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MASTSAS – Mast Structural Analysis Software

User's Manual

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Contract Number: W7707-008062/001/HAL

Contract Scientific Authority: Dr. M. J. Smith, (902) 426-3100 x383

The scientific or technical validity of this Contractor Report is entirely the responsibility of Martec Limited and the contents do not necessarily have the approval or endorsement of Defence R&D Canada.

Defence R&D Canada – Atlantic

Contract Report
DRDC Atlantic CR 2002-199
April 2004

Canada

105-04530/

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Author

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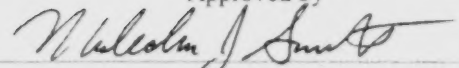
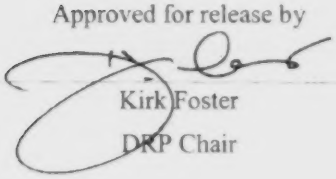
Approved by



M.J. Smith

Contract Scientific Authority

Approved for release by



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Abstract

MASTSAS (MAST Structural Analysis Software) is a special-purpose, PC based computer program for rapid finite element modeling of warship mast structures. The MASTSAS software was developed under contract to DRDC Atlantic, using its HOOD (Hierarchical Object Oriented Database) toolkit. This user's manual is one of a series of three manuals documenting the MASTSAS software. It provides detailed instructions on how to use this MASTSAS model generator to create input data, set up, and run the finite element based analysis programs, and display analysis results.

Résumé

MASTSAS (MAST Structural Analysis Software ou logiciel d'analyse des structures de mâts) est un programme spécialisé pour PC, destiné à la modélisation rapide par la méthode des éléments finis des structures des mâts des navires de guerre. Le logiciel MASTSAS a été développé par un entrepreneur lié par contrat à RDDC Atlantique, au moyen de la boîte à outils HOOD (Hierarchical Object Oriented Database ou base de données hiérarchique orientée objet) de cet organisme. Le présent guide d'utilisation fait partie d'une série de trois manuels qui documentent le logiciel MASTSAS. Il fournit des directives détaillées sur la façon d'utiliser le générateur de modèle MASTSAS pour créer des données d'entrée, configurer et exécuter les programmes d'analyse par la méthode des éléments finis, et afficher les résultats de l'analyse.

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Executive summary

Introduction

Under the FELEX (Frigate Equipment Life Extension) project, a redesign of the HALIFAX class main mast is being considered for its mid-life refit. Since 1999, DRDC Atlantic has been developing capabilities for efficient modelling of warship mast structures, principally through the development of the MASTSAS software, so as to aid the engineering analysis of new or existing mast designs.

Principal Results

The MASTSAS software provides capabilities for efficiently modeling mast structures typical of warships. These include lattice masts (currently used on CF vessels), and enclosed, or plated, mast designs. Metallic and composite structural materials are supported. The report provides a user's manual for the MASTSAS software.

Significance of Results

Engineering assessments of new or existing mast designs can be performed with MASTSAS in an efficient manner. The tools provided in MASTSAS and the design features of the software allow changes in the design to be assessed more rapidly than with a generic FE modelling package.

Future Plans

The development of the software was completed in 2003. No further development is planned at this time, although some modification may be required for the FELEX project.

Brennan, D. P., Koko, T. S., and Rushton, P. A. (2004). MASTSAS – Mast Structural Analysis Software. User's Manual. DRDC Atlantic CR 2002-199. Defence R&D Canada – Atlantic.

Sommaire

Introduction

Dans le cadre du projet FELEX (Frigate Equipment Life Extension ou prolongation de la vie de l'équipement des frégates), on envisage la réingénierie du grand mât des navires de la classe HALIFAX, pour leur remise à niveau de mi-vie. Depuis 1999, RDDC Atlantique élabore des capacités permettant de modéliser de façon efficace les structures des mâts des navires de guerre, principalement grâce au développement du logiciel MASTSAS, afin de faciliter l'analyse technique des nouveaux modèles de mât ou des modèles de mât existants.

Principaux résultats

Le logiciel MASTSAS est doté de fonctionnalités qui permettent de modéliser de façon efficace les structures de mât que l'on retrouve sur les navires de guerre. Ces structures comprennent les mâts-treillis (utilisés actuellement sur les navires des FC), ainsi que des modèles de mât à structure fermée ou composée. Ce logiciel prend en charge les structures en matériau métallique ou composite. Le rapport présente un guide d'utilisation du logiciel MASTSAS.

Portée

MASTSAS permet d'effectuer une évaluation technique efficace des nouveaux modèles de mât ainsi que des modèles existants. Les outils intégrés à MASTSAS ainsi que les fonctions de conception du logiciel permettent d'évaluer les changements apportés à la conception, plus rapidement qu'avec un logiciel de modélisation par éléments finis général.

Futures recherches

Le développement du logiciel a été achevé en 2003. Pour le moment, on ne prévoit pas d'autre travail de développement, bien qu'il se peut que certaines modifications doivent être apportées pour le projet FELEX.

Brennan, D. P., Koko, T. S., et Rushton, P. A. (2004). MASTSAS – Mast Structural Analysis Software. User's Manual. RDDC Atlantique CR 2002-199. R & D pour la défense Canada – Atlantique.

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1. INTRODUCTION

1.1 Background

MASTSAS (acronym for MAST Structural Analysis Software) is a special-purpose, PC based computer program for rapid finite element modeling of masts. The MASTSAS software development is based on the Object Oriented Programming (OOP) technology. The system is built on the HOOD (Hierarchical Object Oriented Database) toolkit [1]. Thus all MASTSAS objects inherit from HOOD base classes and thus they inherit all the functionality of the base classes such as searching, I/O, setting privileges, as well as graphics functionality such as drawing and picking.

In this document, detailed instructions are given on how to use this MASTSAS model generator to create input data, setup and run the finite element based analysis programs, and display analysis results. It should be noticed that in this report, only those HOOD functionality which are directly related to the present application are described.

MASTSAS provides the following capabilities and features:

- Rapid geometric modeling of lattice, enclosed or combined lattice-enclosed masts;
- Rapid finite element modeling of the various types of masts;
- Interface with DSA-VAST and ANSYS finite element packages;
- Special-purpose post-processing to verify integrity of mast structures, based on strength, stability and vortex shedding criteria;
- Capabilities for defining and applying various types of loads (wind, blast sea load, self weight, and underwater shock) to mast structures;
- Capabilities for modeling masts made of metallic or composite materials;
- Provides a user friendly, PC based modeling environment

1.2 MASTSAS Documentation

The MASTSAS software documentation is presented in three volumes as follows:

- Volume 1 (this volume) contains the User's Manual that provides guidance on the use of the software system
- Volume 2 contains the Reference Manual that provides the theoretical foundations and details on the capabilities offered by the program.
- Volume 3 contains the Examples Manual that provides sample problems/models generated by the MASTSAS system.

1.3 Organization of this Manual

The remainder of this manual is organized as follows:

Chapter 2: Provides an overview of the minimum MASTSAS hardware requirements and installation procedures.

Chapter 3: Describes how to maneuver throughout the MASTSAS system using a combination of menus, toolbar options, and scene graph trees. Basic features of the MASTSAS system are highlighted.

Chapter 4: Presents a brief overview of mast modeling procedures.

Chapter 5: Presents a detailed review of the procedures required for successful geometric modeling of mast systems. The chapter discusses components such as main and auxiliary trunks, yardarms, stiffened panels, cutouts, and braces.

Chapter 6: Discusses the procedures to be followed in attaching equipment to mast systems.

Chapter 7: Discusses the steps involved in creating and applying boundary conditions to a mast structure.

Chapter 8: Presents details regarding application of the various types of loads to a mast structure.

Chapter 9: Provides an overview of the procedures to be followed in creating finite element models of mast geometries and setting up the finite element analysis data for various finite element packages.

Chapter 10: Discusses the use of MASTSAS' post-processing capabilities upon completion of a finite element analysis of the system.

Chapter 11: Provides a collection of relevant references.

2. INSTALLATION AND HARDWARE REQUIREMENTS

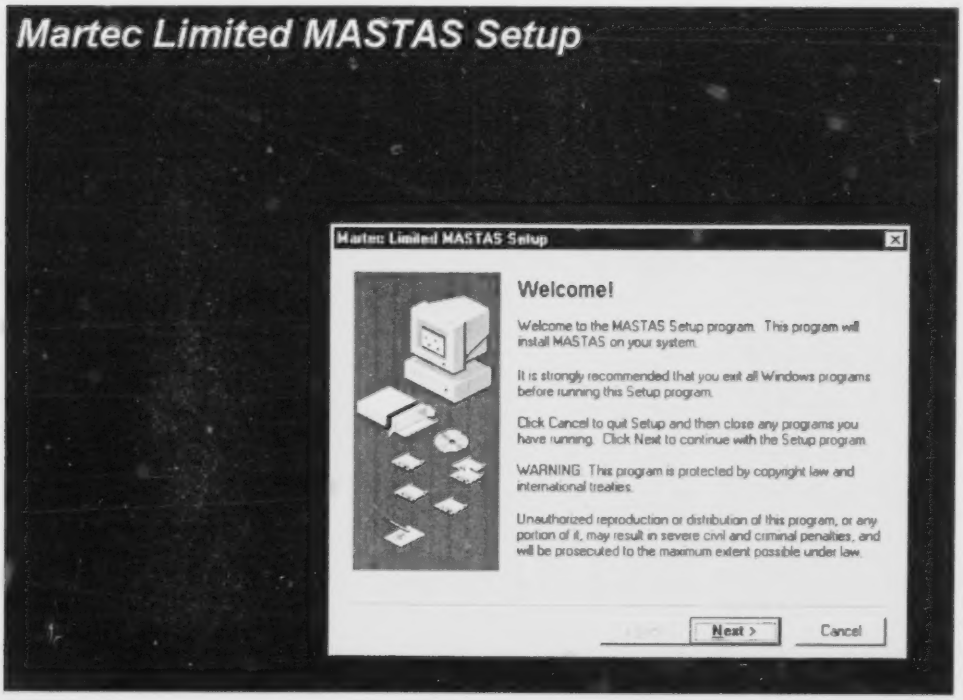
2.1 System Requirements

As a minimum, MASTSAS requires a host PC with a Pentium III processor, 64mB of RAM, a graphics accelerator, and whose operating environment is Windows 98 or higher.

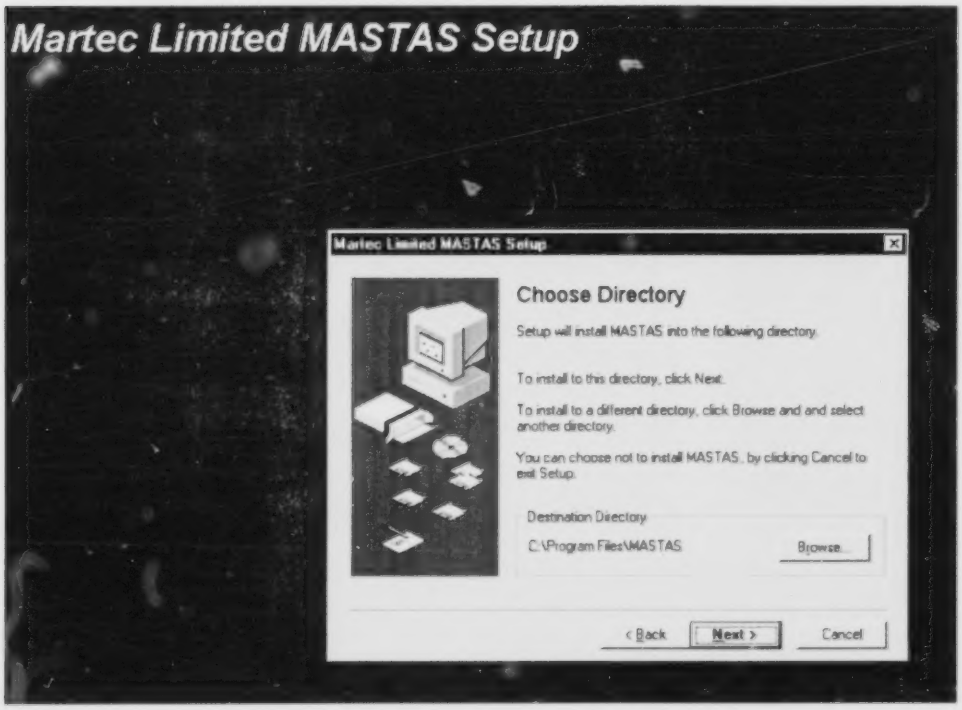
2.2 Installation

Installation and launching of the MASTSAS software is outlined through the following step-by-step procedure.

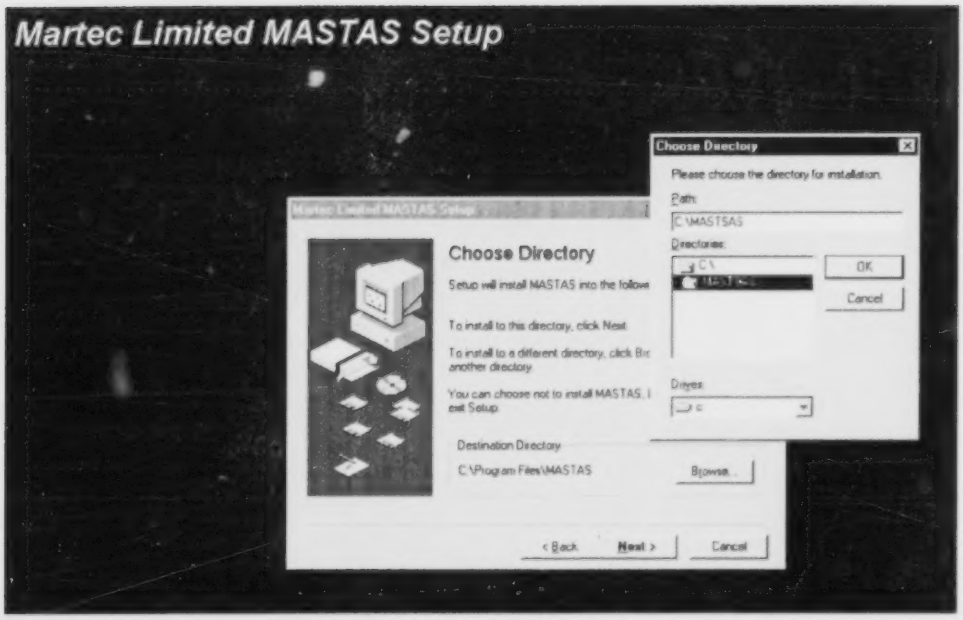
- **STEP 1**: Launch the MASTSAS setup by clicking the "*Setup.exe*" application on the MASTSAS CD provided. The welcome screen shown below will appear. Click the "*Next*" button to advance through the setup procedure.

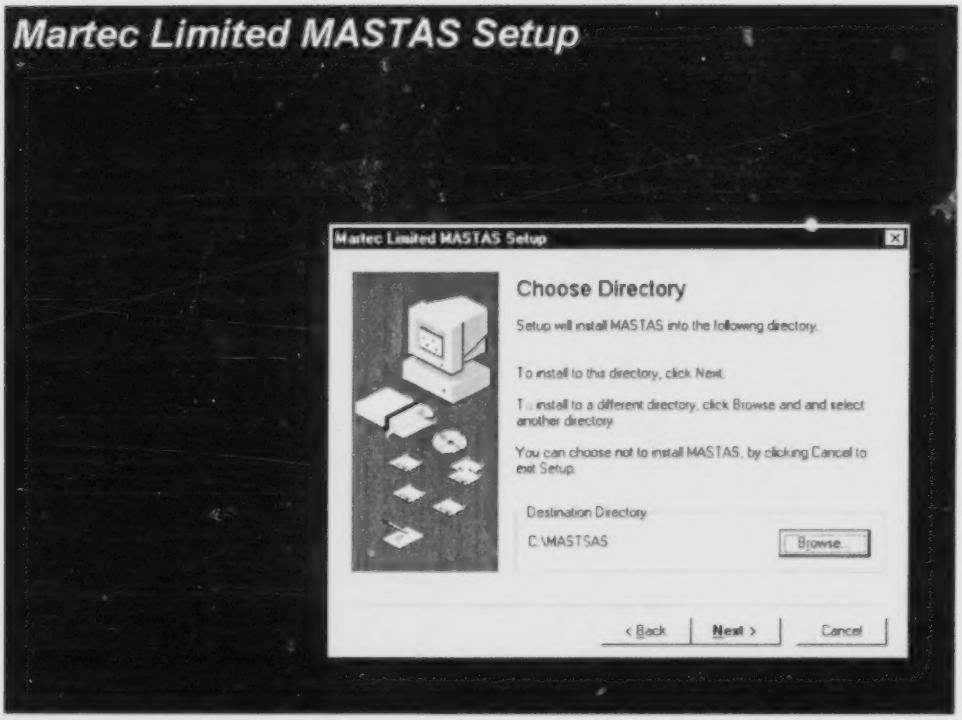

Martec Limited MASTAS Setup
Martec Limited MASTAS Setup
Welcome!
Welcome to the MASTAS Setup program. This program will install MASTAS on your system.
It is strongly recommended that you exit all Windows programs before running this Setup program.
Click Cancel to quit Setup and then close any programs you have running. Click Next to continue with the Setup program.
WARNING: This program is protected by copyright law and international treaties.
Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.
Next >
Cancel

- **STEP 2**: The user will be prompted to choose a directory location into which the MASTSAS software will be installed.

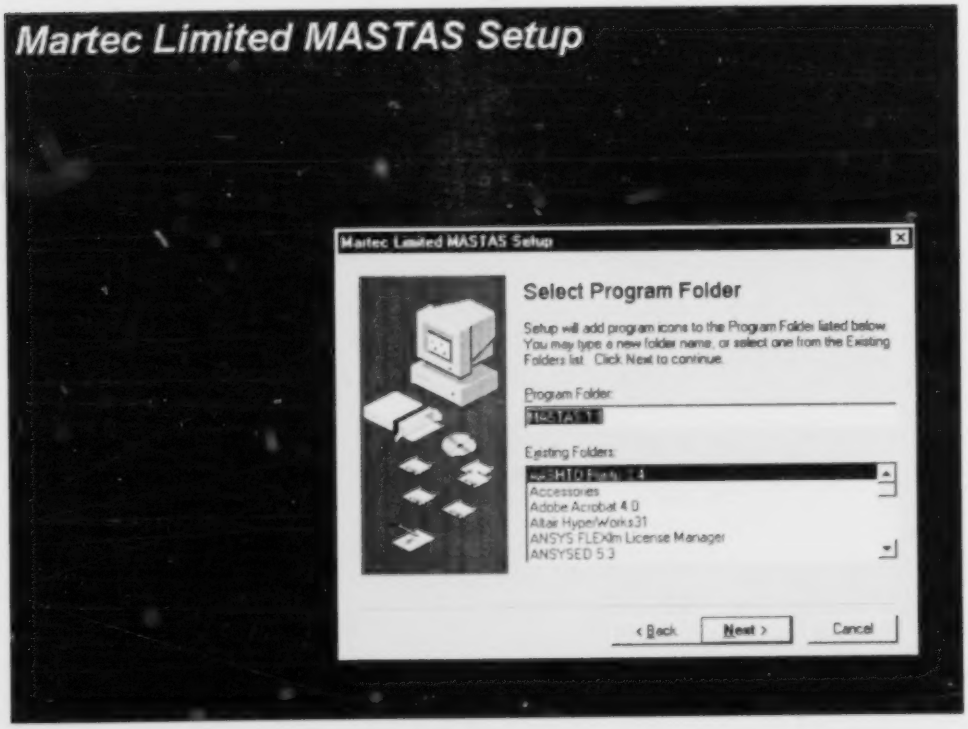

Martec Limited MASTAS Setup
Martec Limited MASTAS Setup
Choose Directory
Setup will install MASTAS into the following directory.
To install to this directory, click Next.
To install to a different directory, click Browse and and select another directory.
You can choose not to install MASTAS, by clicking Cancel to exit Setup.
Destination Directory
C:\Program Files\MASTAS
Browse...
< Back
Next >
Cancel

To select a destination directory other than the default location shown above, simply click the "*Browse*" button and select a suitable installation location (see inset in figure below). Click the "*OK*" button when completed, and then select "*Next*" to advance. The next figure shows confirmation of the selected destination directory.


Martec Limited MASTAS Setup
Choose Directory
Please choose the directory for installation.
Path:
C:\MASTSAS
Directories:
OK
Cancel
Drives:
Choose Directory
Setup will install MASTAS into the follow
To install to this directory, click Next.
To install to a different directory, click Bro
another directory.
You can choose not to install MASTAS, I
exit Setup.
Destination Directory
C:\Program Files\MASTAS
Browse...
< Back
Next >
Cancel


Martec Limited MASTAS Setup
Martec Limited MASTAS Setup
Choose Directory
Setup will install MASTAS into the following directory.
To install to this directory, click Next.
To install to a different directory, click Browse and and select another directory.
You can choose not to install MASTAS, by clicking Cancel to exit Setup.
Destination Directory
C:\MASTSAS
Browse...
< Back
Next >
Cancel

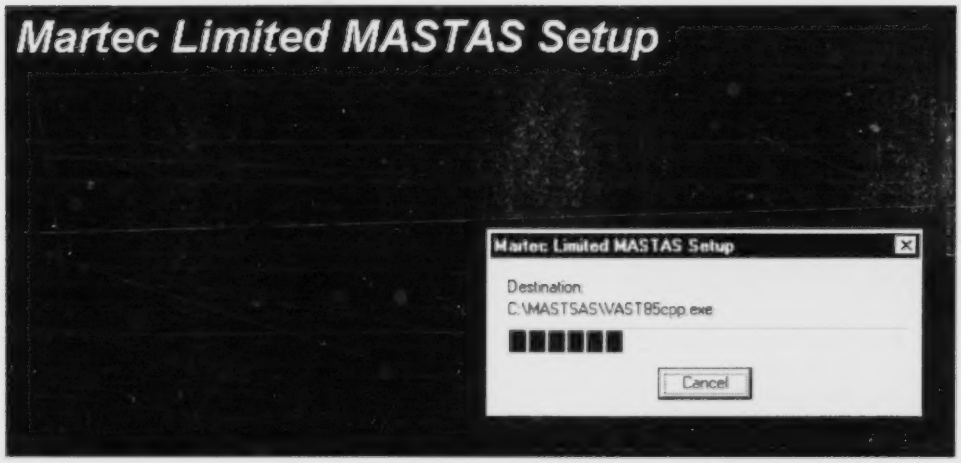
- **STEP 3**: Select a program folder name for installation of all MASTSAS program icons. Click "*Next*" to continue.


Martec Limited MASTAS Setup
Martec Limited MASTAS Setup
Select Program Folder
Setup will add program icons to the Program Folder listed below. You may type a new folder name, or select one from the Existing Folders list. Click Next to continue.
Program Folder:
Existing Folders:
Accessories
Adobe Acrobat 4.0
Altair HyperWorks31
ANSYS FLEXlm License Manager
ANSYSED 5.3
< Back
Next >
Cancel

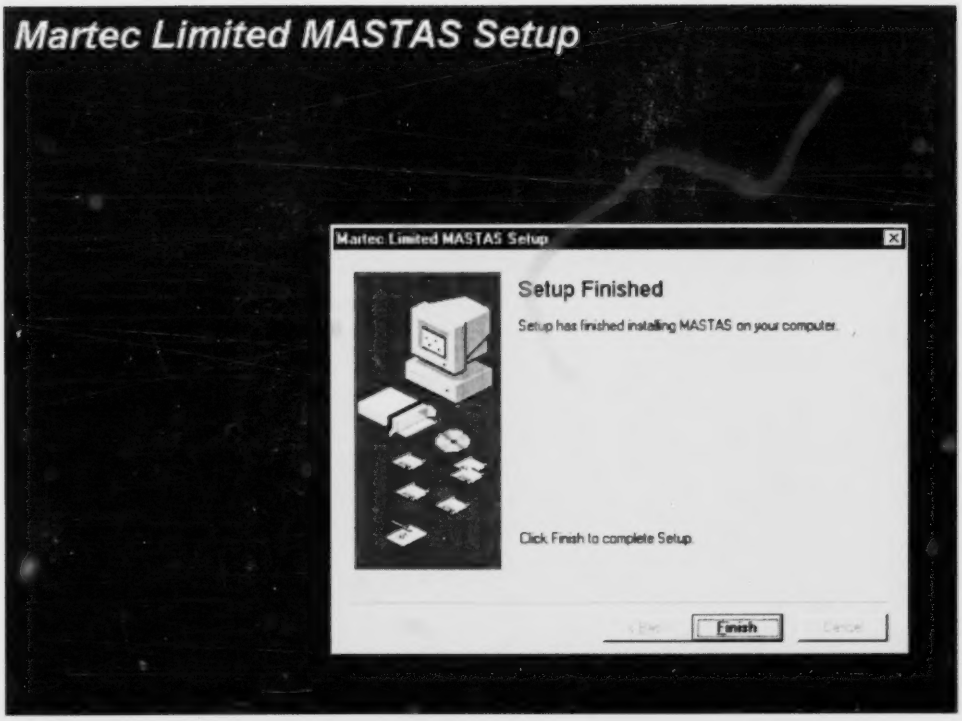
- **STEP 4**: MASTSAS files can now be copied to the selected destination directory/program folder location. Any previous installation settings can be reviewed by clicking the "*Back*" button.

Martec Limited MASTAS Setup
Martec Limited MASTAS Setup
Start Copying Files
The Setup Program now has enough information to start copying MASTAS files to your computer. If you want to review or change any settings, click Back.
To start copying MASTAS files, click Next.
< Back
Next >
Cancel

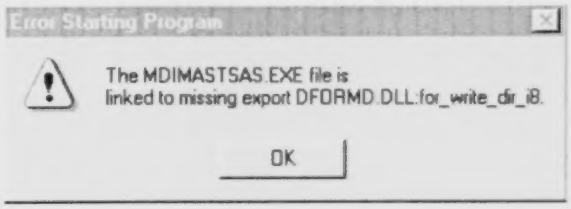
Click "*Next*" to begin copying the files.



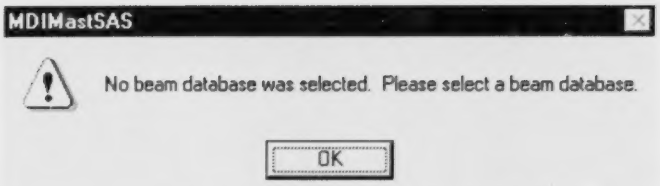
The user will be notified when installation of MASTSAS is complete. To complete the setup process, click "*Finish*".


Martec Limited MASTAS Setup
Martec Limited MASTAS Setup
Setup Finished
Setup has finished installing MASTAS on your computer.
Click Finish to complete Setup.
Finish

- **STEP 5**: MASTSAS can now be launched by clicking the "*MDIMastSAS.exe*" application located in the destination directory. In some cases, the following error message will be displayed. If such a message is encountered, the user should launch the "*VFRUN66AI.exe*" application (also located in the destination directory), which will update the user's environment to allow MASTSAS to function properly.



- **STEP 6**: Upon launching MASTSAS for the first time, some MASTSAS default parameters concerning material properties, beam properties, loading, equipment, etc. may require modification, resulting in the warning message shown below. In such instances, the user may have to modify the locations of their corresponding database files, which are specified within the "*MDIMastSAS.INI*" file. For example, the material database file ("*materialDB.mdm*") may have to be relocated from 'C:\MASTSAS\Data\materialDB.mdm' to 'C:\MASTSAS\materialDB.mdm'.


MDIMastSAS
No beam database was selected. Please select a beam database.
OK

3. GETTING AROUND THE MASTSAS SYSTEM

3.1 User Interaction Through Menus

The MASTSAS main menu provides user's with access to a wide range of modelling and analysis features (see Figures 3.1 and 3.2).

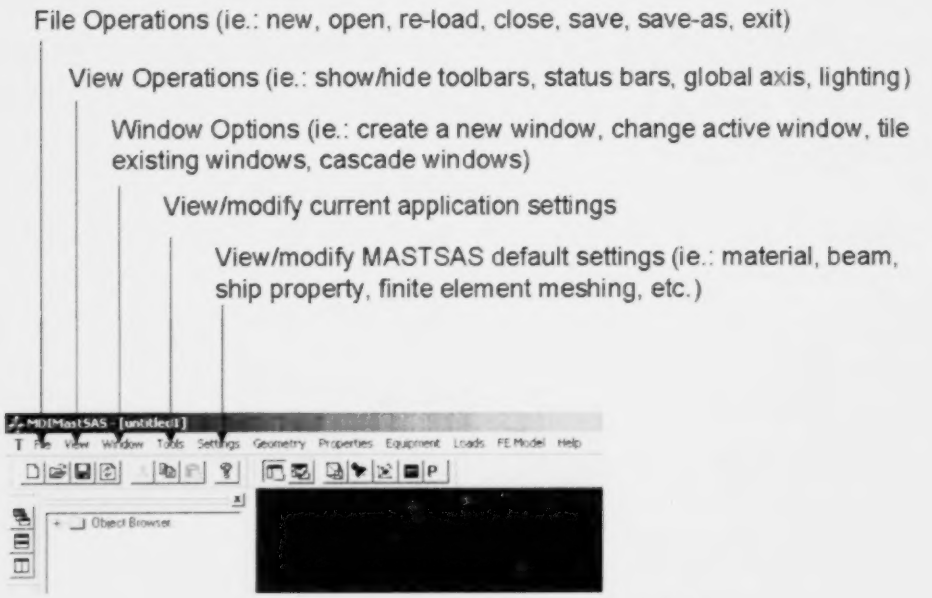

File Operations (ie.: new, open, re-load, close, save, save-as, exit)
View Operations (ie.: show/hide toolbars, status bars, global axis, lighting)
Window Options (ie.: create a new window, change active window, tile existing windows, cascade windows)
View/modify current application settings
View/modify MASTSAS default settings (ie.: material, beam, ship property, finite element meshing, etc.)
MDIMastSAS - [untitled1]
File View Window Tools Settings Geometry Properties Equipment Loads FE Model Help
Object Browser

Figure 3.1: MASTSAS Main Menu (1)

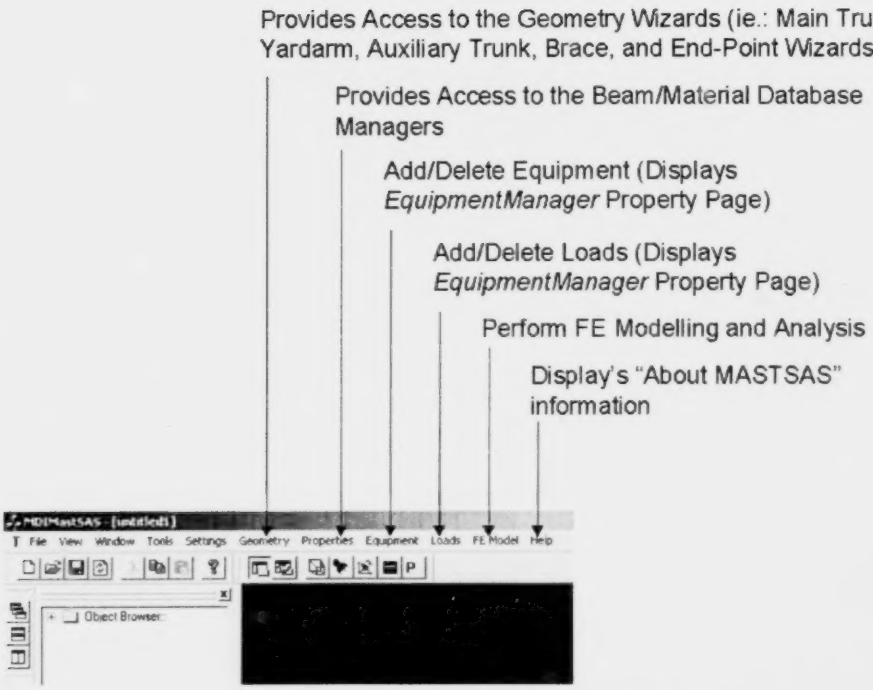

Provides Access to the Geometry Wizards (ie.: Main Trunk, Yardarm, Auxiliary Trunk, Brace, and End-Point Wizards)
Provides Access to the Beam/Material Database Managers
Add/Delete Equipment (Displays *EquipmentManager* Property Page)
Add/Delete Loads (Displays *EquipmentManager* Property Page)
Perform FE Modelling and Analysis
Display's "About MASTSAS" information
File View Window Tools Settings Geometry Properties Equipment Loads FE Model Help
Object Browser:

Figure 3.2: MASTSAS Main Menu (2)

3.2 User Interaction Through Toolbars

The MASTSAS toolbars (see Figure 3.3 through 3.5) provides users with quick access (or short-cuts) to many of the most commonly used features of the code.

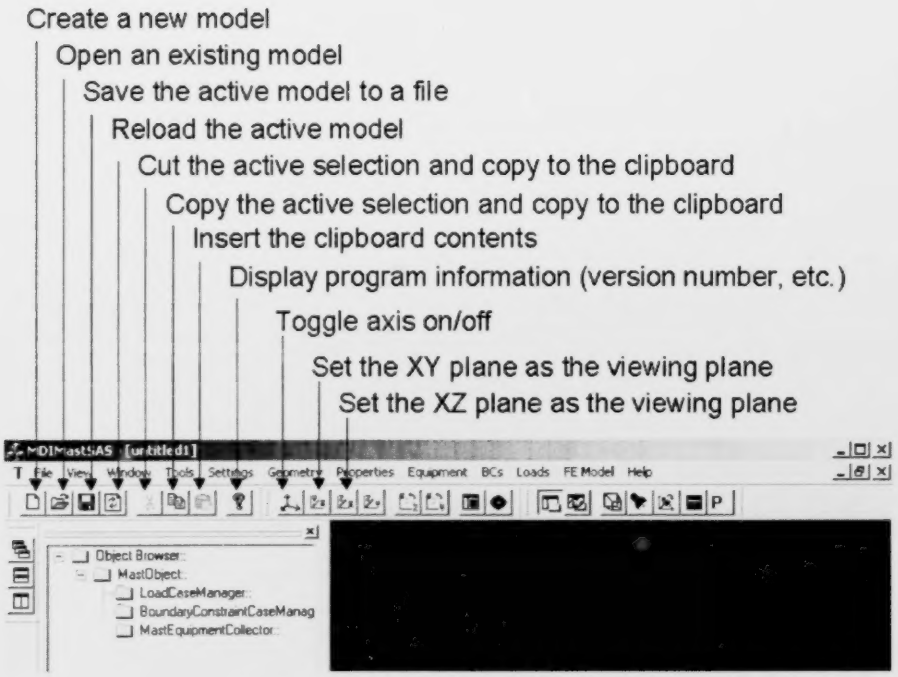


Figure 3.3: MASTSAS Toolbar Options (1)

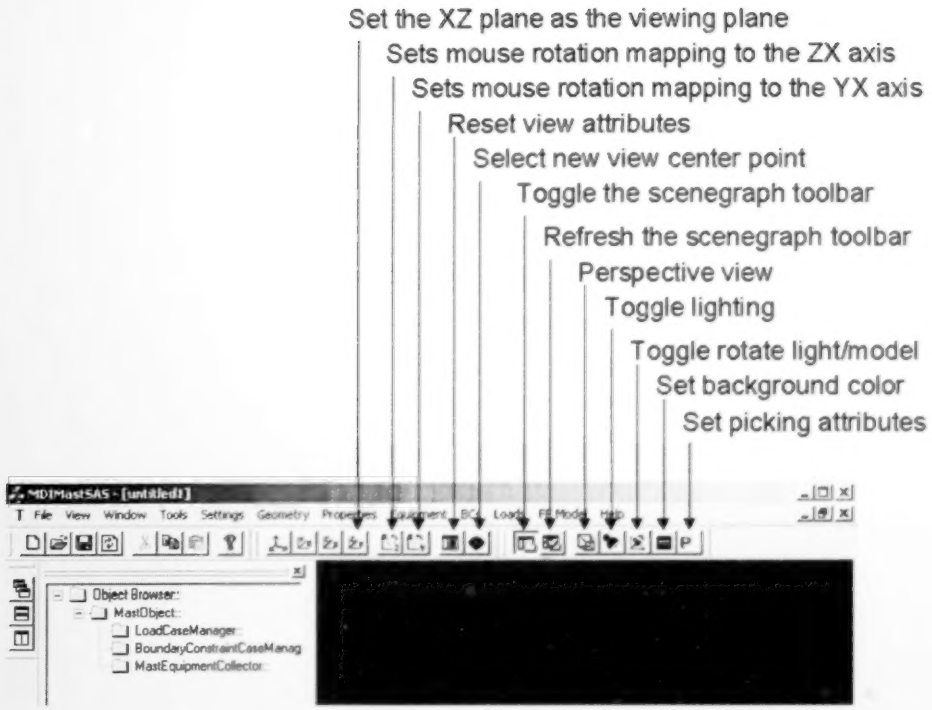


Figure 3.4: MASTSAS Toolbar Options (2)

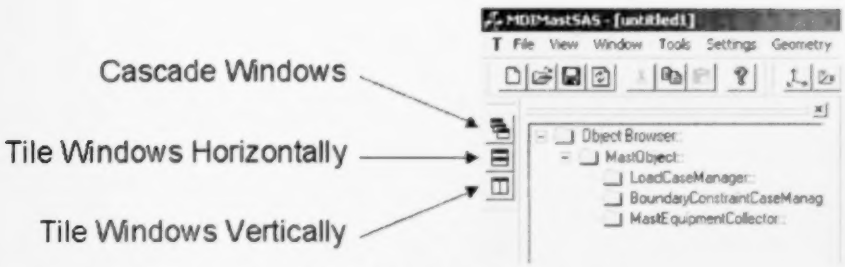


Figure 3.5: MASTSAS Toolbar Options (3)

3.3 User Interaction Through The Main Window

The MASTSAS main window view (see Figure 3.6) provides users with a graphical representation of the mast model. User's can manipulate the display in the main window using a variety of mouse events. For example, holding left mouse button down rotates

models, holding right mouse button down zooms model in and out of screen, while holding shift key and using left mouse button translates (pans) model on screen. In

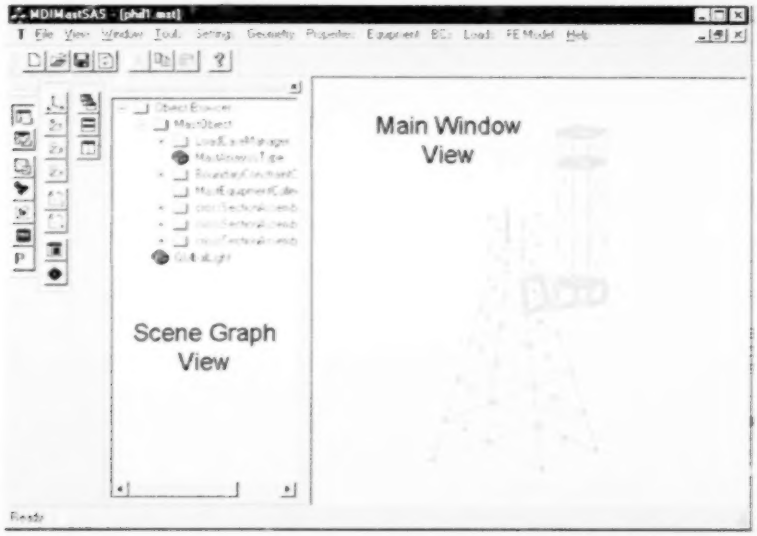


Figure 3.6: MASTSAS Scene Graph and Main Window Views

Double-clicking the left-mouse button over the graphical display of an object results in the display of that object's property page

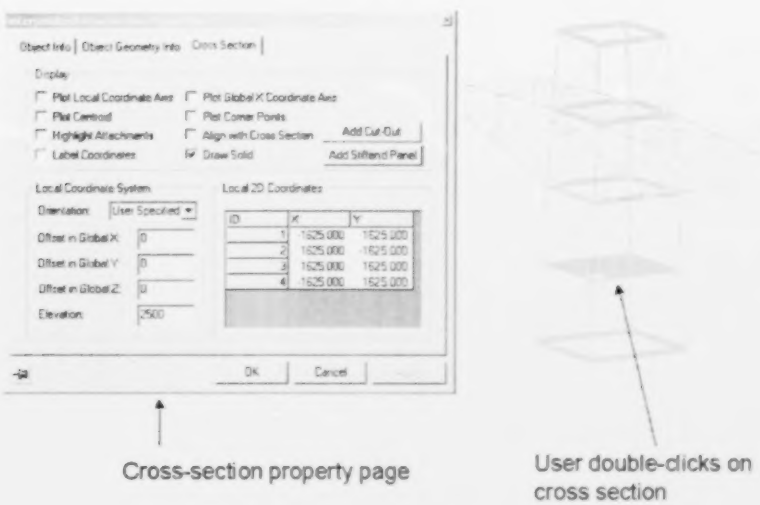


Figure 3.7: Double Clicking an Object in the Main Window

addition, by placing the mouse over an object and double-clicking the left mouse button (see Figure 3.7 above), user's can display the property page for that object. This allows user's to review and/or modify many of the objects attributes, which are listed on the property page.

3.4 User Interaction Through Scene Graph

The model view consists of a collection of objects stored in a hierarchy referred to as the scene graph. A typical scene graph is shown in Figure 3.8. The scene graph is useful for performing certain operations on the model. Some of these operations can only be done through the scene graph, while others can also be performed directly from the model view. Figure 3.9 shows the full list of operations that are available and is accessed by right-clicking on an entry in the list.

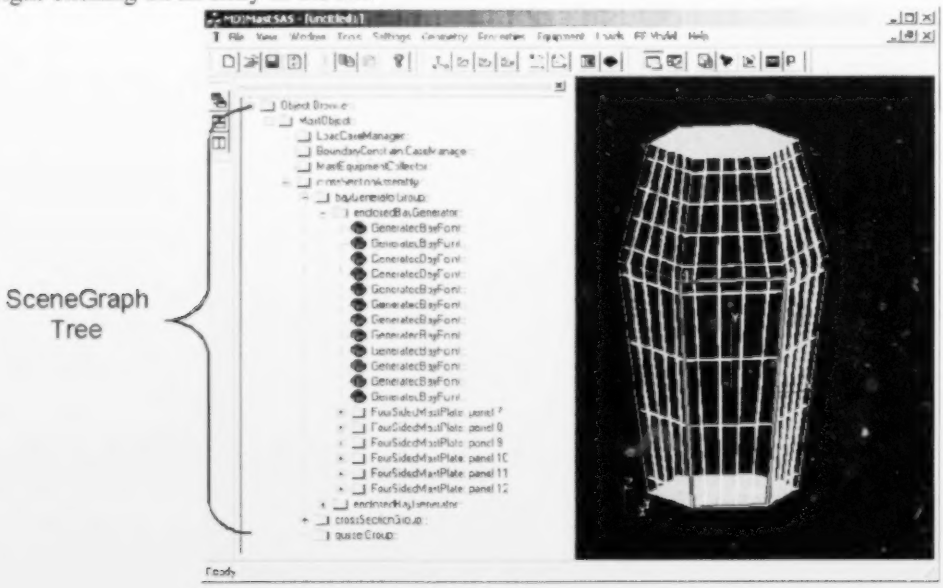


Figure 3.8: Typical MASTSAS Scene Graph

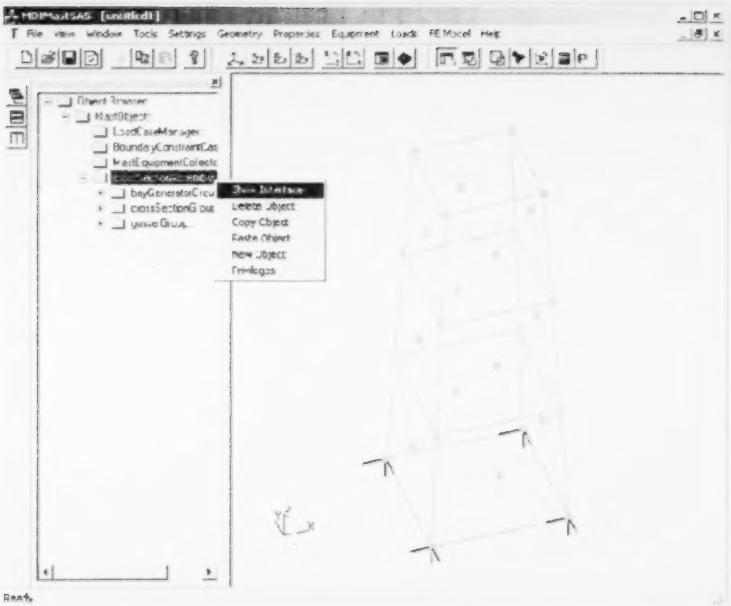


Figure 3.9: MASTSAS Scene Graph Tree Control Operations

3.4.1 *Show Interface*

This operation is identical to double clicking on an object in the model view with the left mouse button. Invoking this operation displays the property page for the selected object.

3.4.2 *Delete Object*

This operation removes the object from the scene. Deleting an attachment point will cause connected isolators to be become partially undefined. Such isolators will be drawn as a sphere and must be reconnected to another attachment point before the model can be calculated.

3.4.3 *Copy Object*

Copying an object (such as a brace) is an easy way to avoid having to re-specify all of the object's properties.

3.4.4 *Paste Object*

Pasting an object inserts a copy of the data currently stored in the clipboard into the scenegraph. It is important to note that pasting data into the scenegraph can result in unexpected (or undesirable) behavior, and is not recommended.

3.4.5 *New Object*

Selecting the new object option allows users to add a new mast object into the scenegraph. User's should be aware, however, that this can result in undesirable model behavior.

3.4.6 *Privileges*

Selection of the privileges option allows users to modify some of the basic properties of an object, such as whether the object is visible or whether the object can be deleted. In general, however, user's will not have to modify the default privileges set by the MASTSAS code.

3.5 Creating a New Project

The first step in creating a MASTSAS model is to create a new project. This is done by either selecting the "*New*" option from the "*File*" menu (as shown in Figure 3.10) or clicking the "*New*" button on the toolbar.

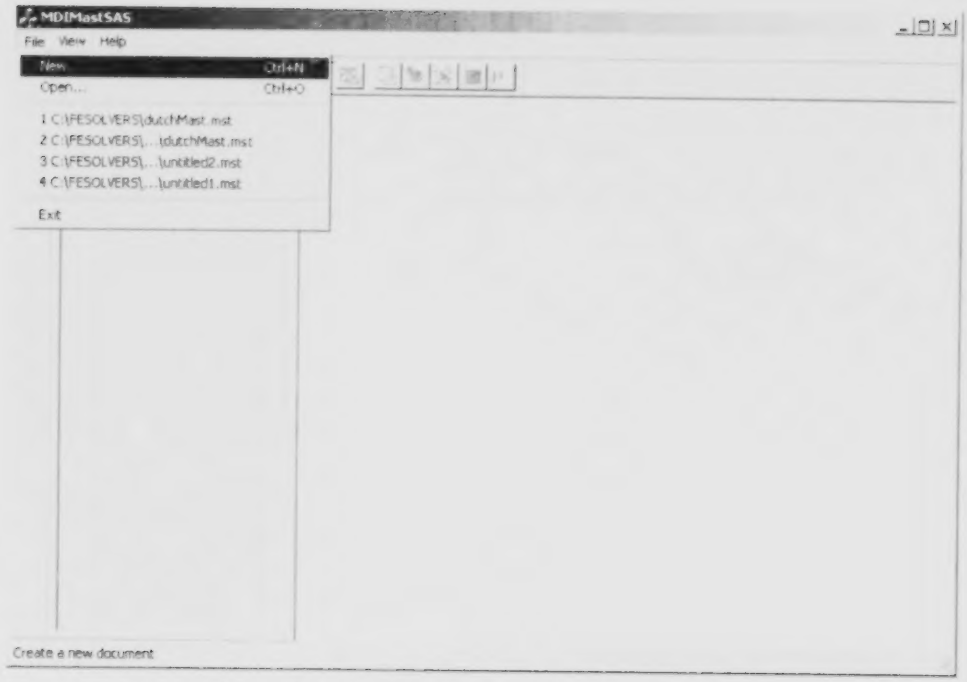


Figure 3.10: Opening a New MASTSAS Project

3.6 Opening an Existing Project

To continue working with an existing model, load the file by either selecting "*Open*" from the "*File*" menu (see Figure 3.11) or clicking the "*Open*" button on the toolbar.

Figure 3.11: Opening an Existing MASTSAS Project

3.7 Changing Project Settings

To review or modify the current project settings, select the "*Settings*" item from the "*Project*" menu, as shown in Figure 3.12). The "*Project Settings*" dialog box (see Figure 3.13) will be displayed.

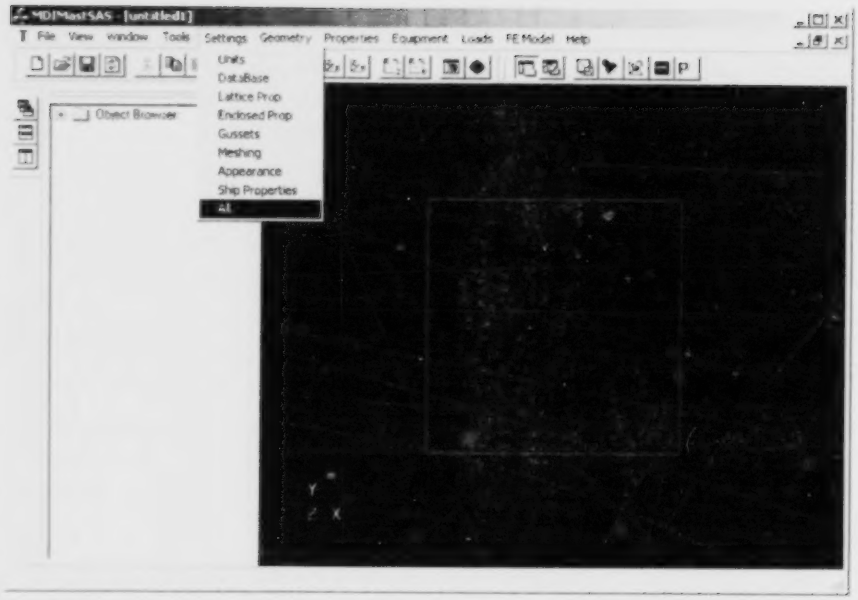


Figure 3.12: Accessing the MASTSAS Settings

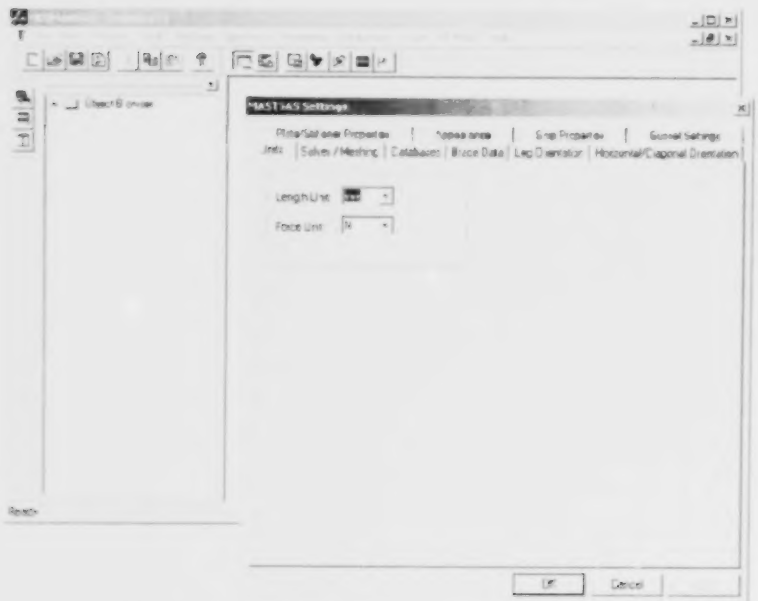


Figure 3.13: MASTSAS Settings Dialog Box

3.8 Material Database Manager

The material database manager is used to review and modify material types. It provides a list of all the material properties currently available in the MASTSAS database. Through the material database manager dialog box (Figure 3.14), the user can view, edit, insert and delete material properties. The filter, which is shown in the left side of the dialog box below, is a standard HOOD capability for imposing criteria when searching through the database.

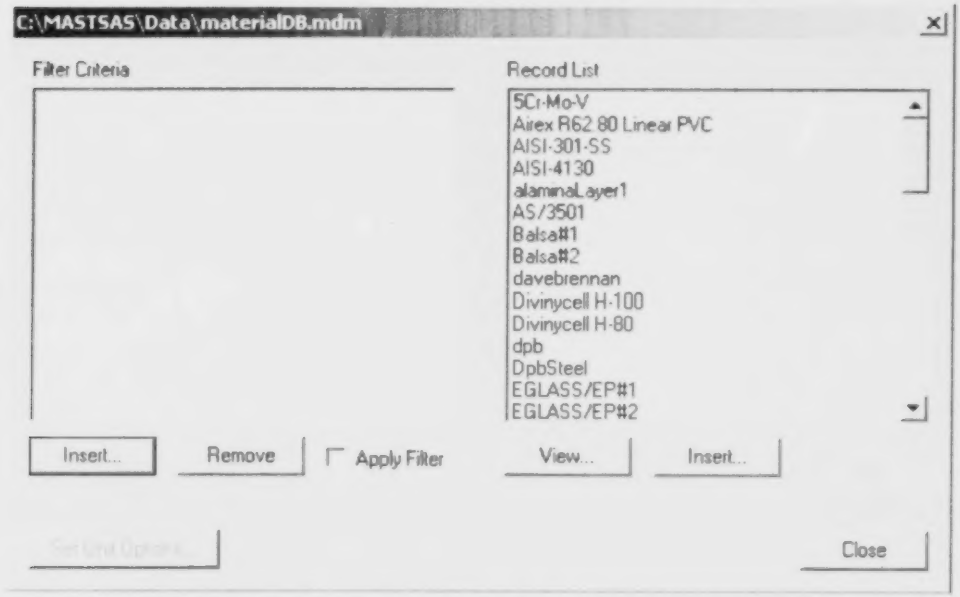


Figure 3.14: MASTSAS Material Database Dialog Box

3.9 Beam Database Manager

The beam database manager is used to review and modify beam types. It provides a list of all the beam properties currently available in the MASTSAS database. Through the beam database manager dialog box (Figure 3.15), the user can view, edit, insert and delete beam properties. The filter, which is shown in the left side of the dialog box, is a standard HOOD capability for imposing criteria when searching through the database.

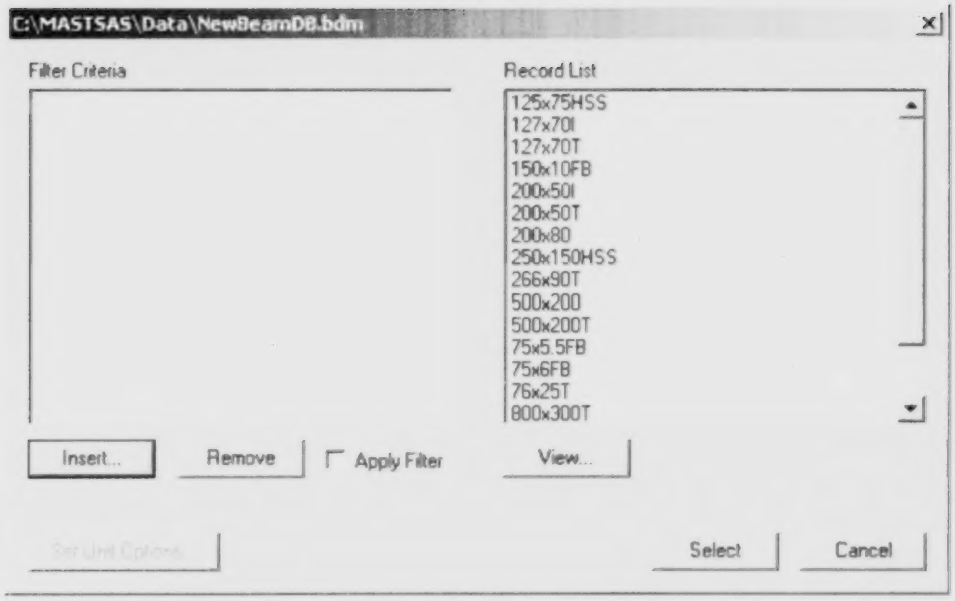


Figure 3.15: MASTSAS Beam Database Dialog Box

3.10 Default MASTSAS Settings

During installation of the MASTSAS program, a file named *MDIMASTSAS.ini* will be copied onto the host PC. This file contains default values for a number of parameters used by the MASTSAS program to generate both geometric and finite element mast models, including:

- units (see Figure 3.16);
- database file names (see Figure 3.17);
- lattice brace properties (see Figure 3.18);
- gusset plate properties (see Figure 3.19);
- stiffened plate properties (see Figure 3.20);
- ship properties (see Figure 3.21); and
- meshing parameters (see Figure 3.22).

Users can review/modify these settings by selecting the various options supplied under the "Setting" tab listed in the main menu (see Figure 3.23). Once modified, the updated settings will be written and saved in the *MDIMASTSAS.ini* file for use in future modeling sessions.

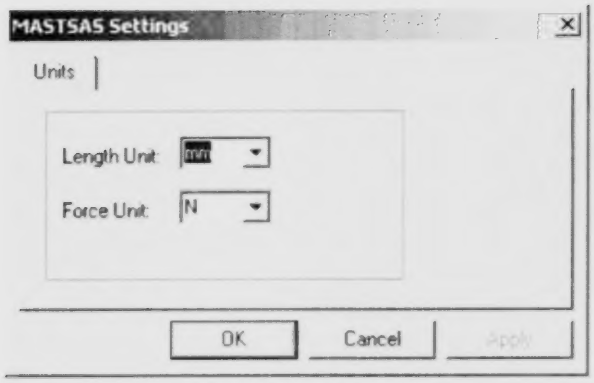


Figure 3.16: Unit Settings GUI

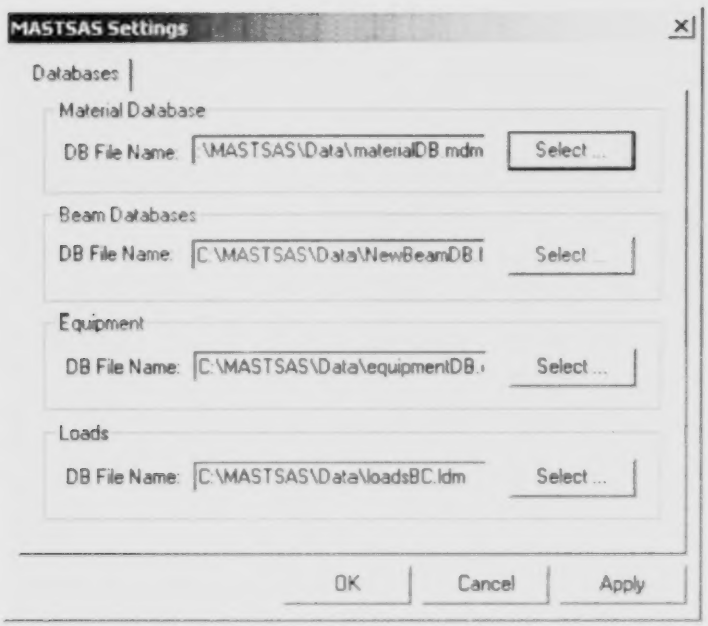


Figure 3.17: Database File Settings GUI

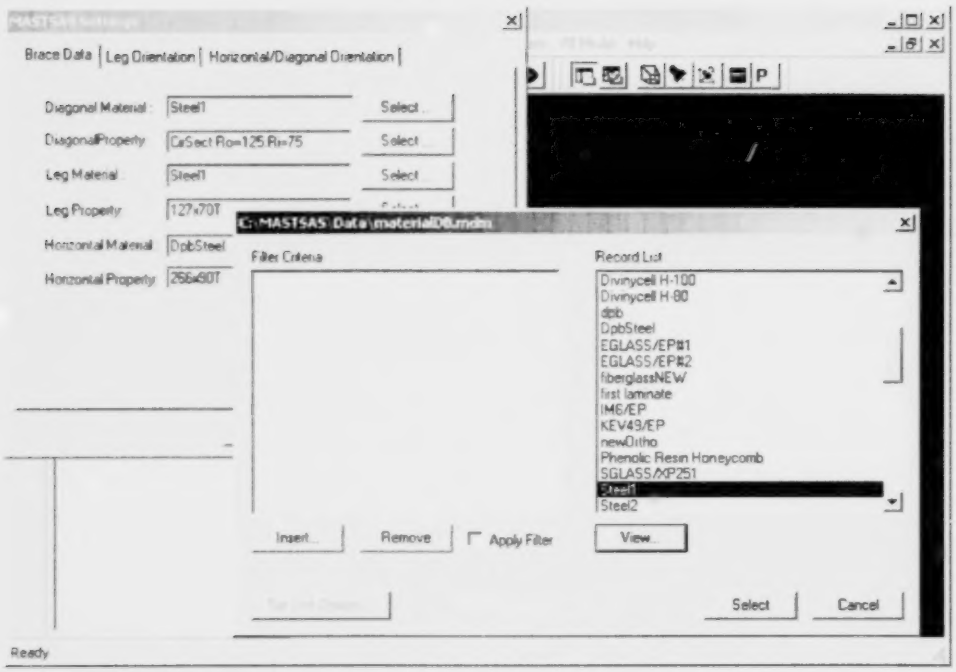


Figure 3.18: Lattice Brace Settings GUI

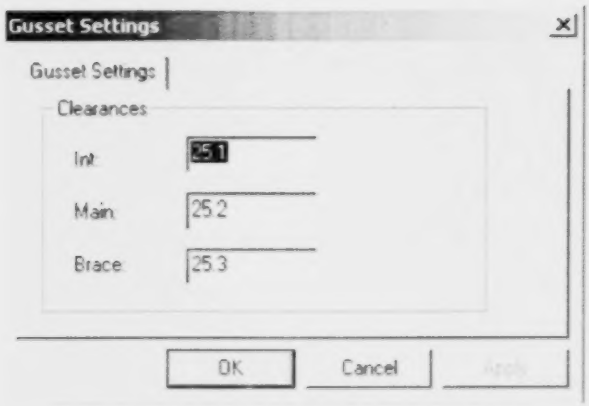


Figure 3.19: Gusset Plate Settings GUI

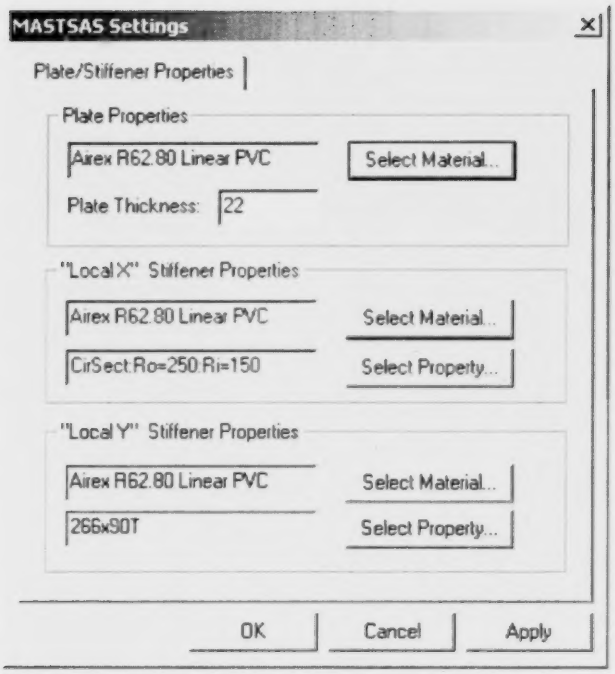


Figure 3.20: Stiffened Plate Settings GUI

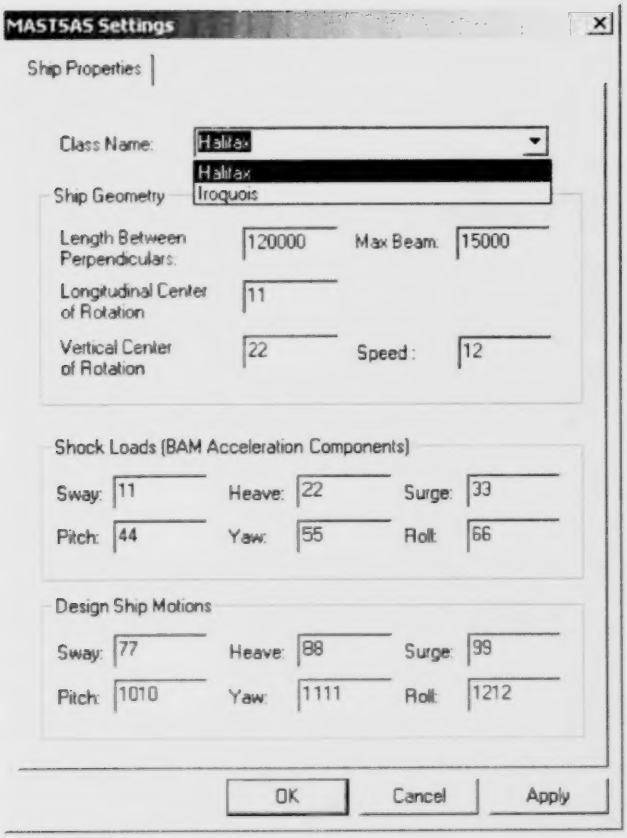


Figure 3.21: Ship Properties Settings GUI

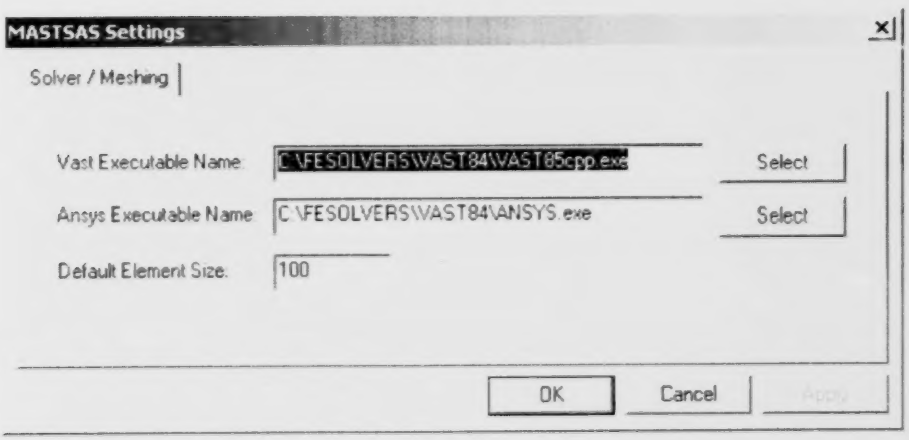


Figure 3.22: Default Meshing Settings GUI

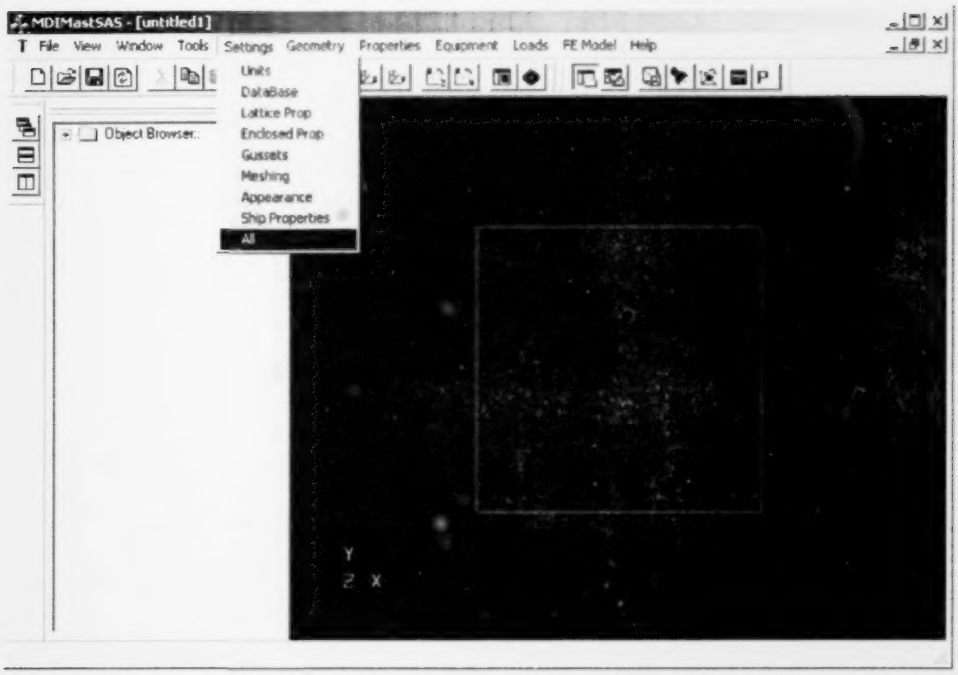


Figure 3.23: Accessing the MASTSAS Settings

3.11 File Management

MASTSAS requires of a number of database files in order to represent the material properties (*material.mdm*), beam section properties (*beam.dbm*), equipment (*equipment.edm*), boundary conditions, and loads (*loads.ldm*). If the MASTSAS code has been successfully installed, these files were copied on to the host computer. User's must take appropriate steps in order to maintain copies of these files to ensure that the code functions properly. Editing or modifying these files outside of the MASTSAS may also prevent the code from functioning properly.

4. GENERAL MAST MODELING PROCEDURES

Successful modeling of mast systems using the MASTSAS software package requires completion of a number of tasks. These tasks may be loosely grouped into a number of categories, including (i) review and/or modification of MASTSAS settings, (ii) create new (or modify existing) mast geometry and components, (iii) attach equipment to mast structure, (iv) define boundary conditions and mast loading, (v) prepare finite element analysis, and (vi) post processing. These various steps are summarized in Figure 4.1 below, and will be discussed in greater detail in the following chapters.

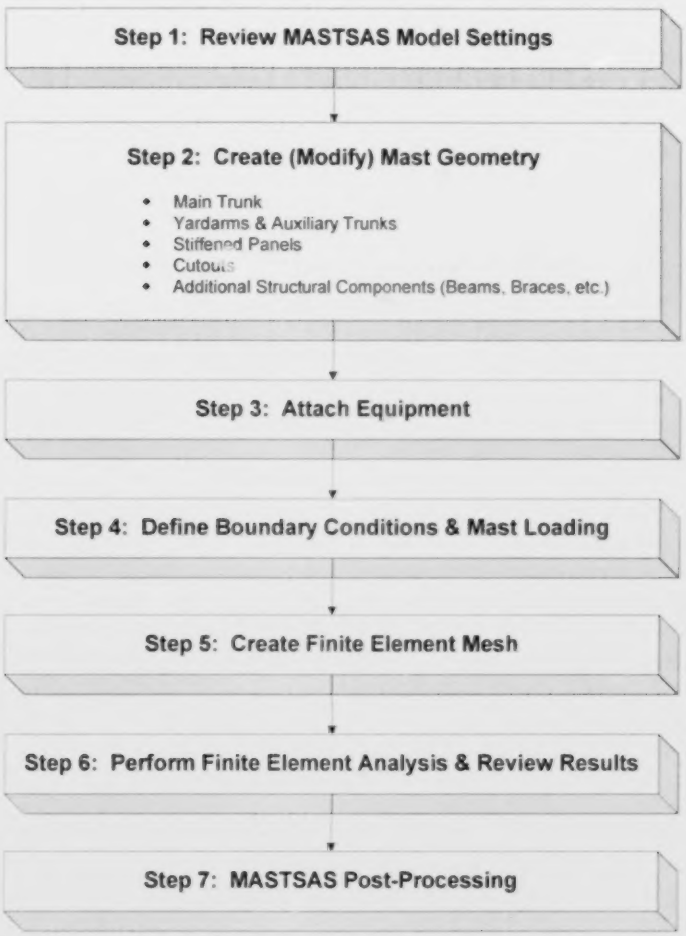

Step 1: Review MASTSAS Model Settings
Step 2: Create (Modify) Mast Geometry
Main Trunk
Yardarms & Auxiliary Trunks
Stiffened Panels
Cutouts
Additional Structural Components (Beams, Braces, etc.)
Step 3: Attach Equipment
Step 4: Define Boundary Conditions & Mast Loading
Step 5: Create Finite Element Mesh
Step 6: Perform Finite Element Analysis & Review Results
Step 7: MASTSAS Post-Processing

Figure 4.1: Summary of MASTSAS Modeling Procedures

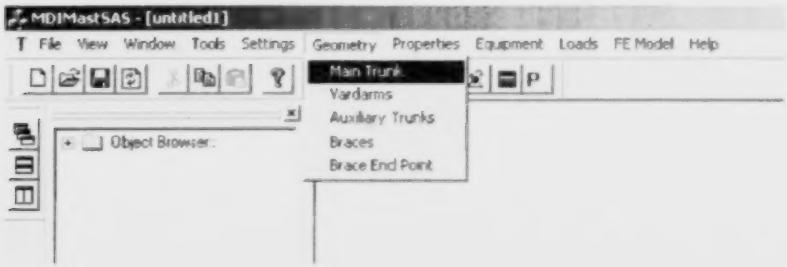
5. GEOMETRIC MODELING

Each of the geometric modeling items included in 'Step 2' above will be discussed in this chapter using a series of step-by-step procedures to walk the user through the process of creating (or modifying) the geometry for a mast structural system.

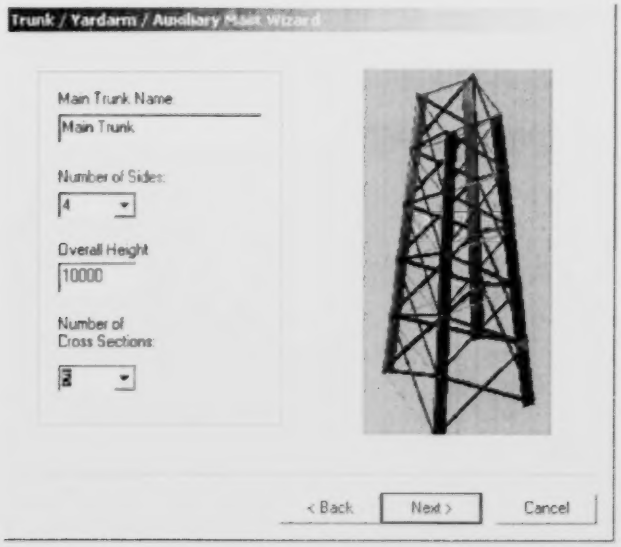
5.1 Creating the Main Trunk of a Mast System

The main trunk constitutes the foundation of any mast system. Creation of the main trunk is accomplished through the following steps:

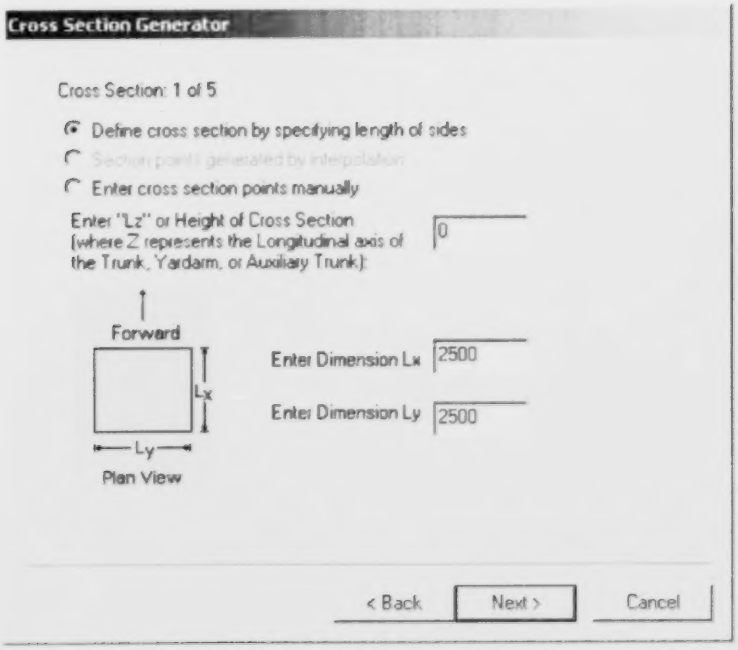
- **STEP 1**: Activate the "*Main Trunk*" wizard through the main menu's "*Geometry*" tab



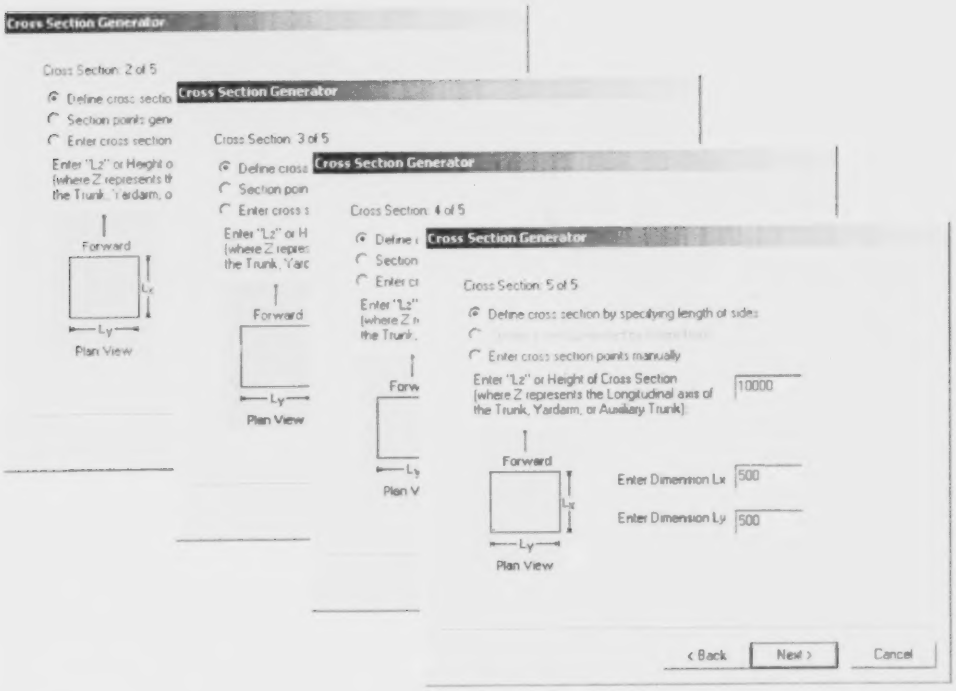
- **STEP 2**: Define the number of sides, overall height, and number of cross sections to be used in constructing the main trunk. Select the "*Next*" button when completed.



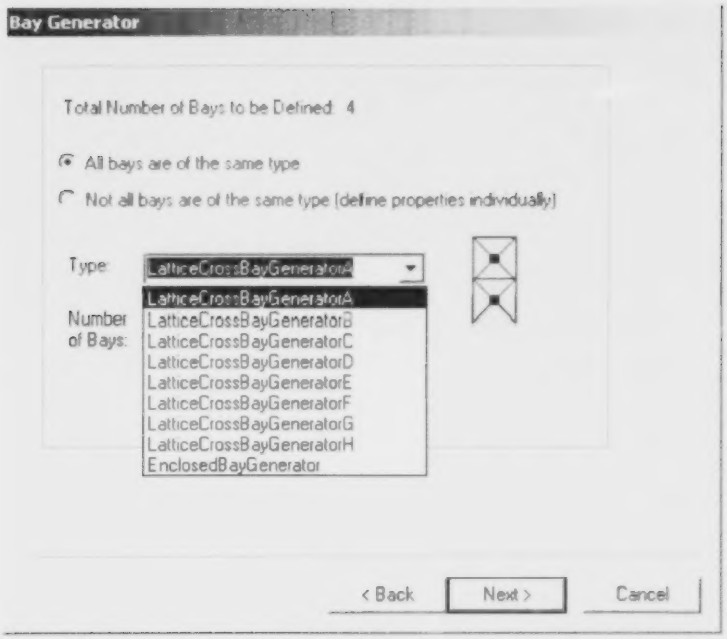
- **STEP 3**: Define the geometry for each of the cross sections specified in Step 2. Cross section geometry may be defined using one of three methods: (i) defining the lengths of each side (common), (ii) entering the local coordinates of the cross section corner points, or (iii) defining the points using interpolation, wherein the corner points are computed by interpolating matching coordinates from neighboring cross-sections. Select the "*Next*" button when completed.



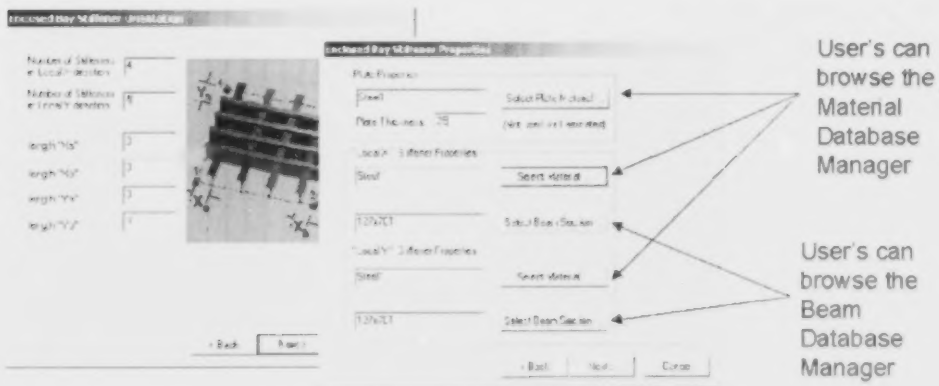
The wizard will prompt the user for cross section geometry for each cross section.



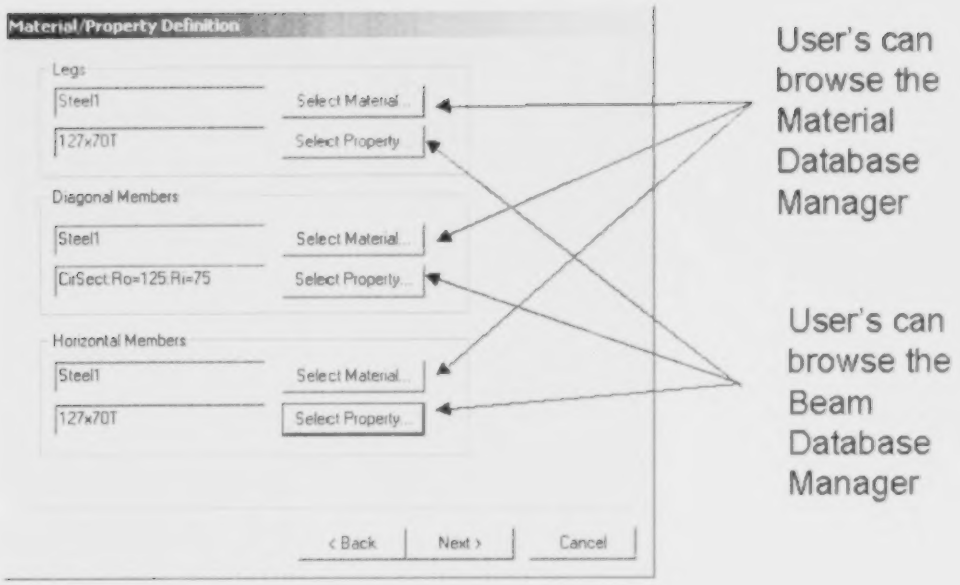
- **STEP 4**: Once all cross-sections have been defined, the wizard prompts the user for a *Bay-Generator* type to be applied. The total number of bays in a mast structure is equal to one less than the total number of cross-sections. The MASTSAS wizard provides users with two options for defining the *Bay-Generators*, namely (i) making all bays the same (all 'enclosed', for example), and (ii) selecting different *Bay-Generators* for each bay (the user may select 'lattice types' A-H or 'enclosed'). Select the "*Next*" button when completed.



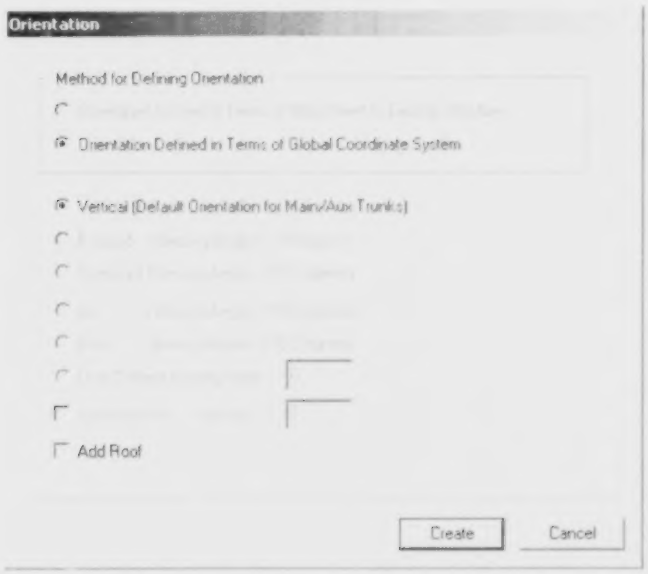
For 'enclosed' *Bay-Generators*, users must supply stiffener and material definitions. The wizard allows users to select material types using the Material Database Manager (see section 3.8), and beam sections from the Beam Database Manager (see section 3.9).



For 'lattice type' *Bay-Generators*, users are prompted for the stiffener properties of all legs, diagonal members, and horizontal members. The wizard allows users to select material types using the Material Database Manager (see section 3.8), and beam sections from the Beam Database Manager (see section 3.9).



- **STEP 5**: Define the global orientation of the main trunk (vertical is the default option). Users have the option of adding a '*roof* panel to cover the top cross section. The user may return to the previous menu at any time by clicking the "*Back*" button. Select the "*Create*" button when completed.



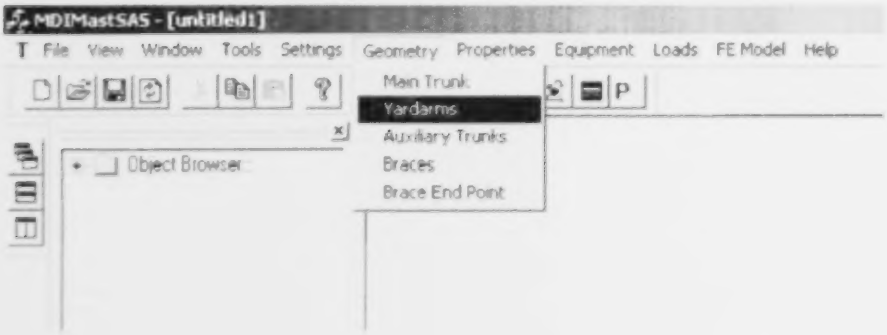
The final result is illustrated below.

Cross-sections only Geometry including stiffeners Finite element model

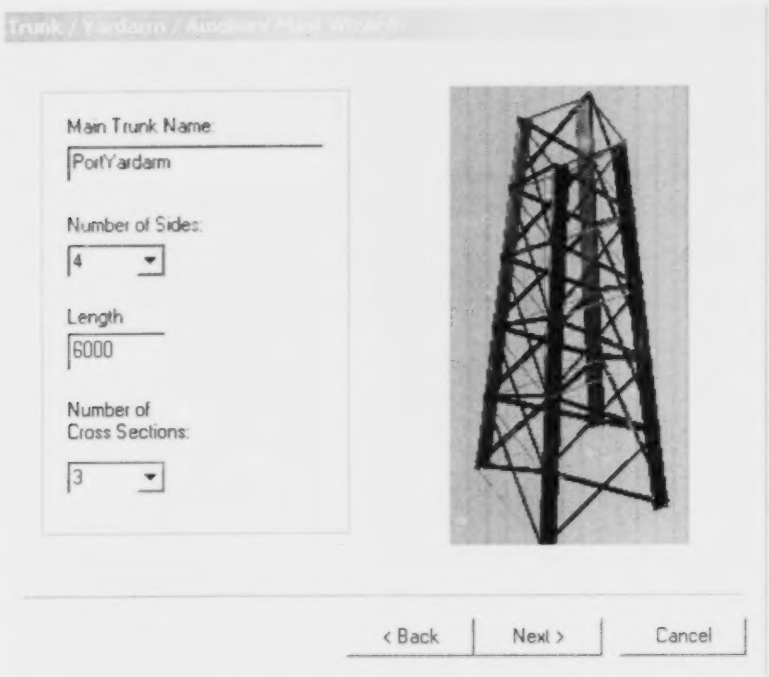
5.2 Creating and Attaching Yardarms to the Main trunk

Mast systems typically include horizontal components known as yardarms. Mast yardarms are created and attached to the main trunk using MASTSAS' "*Yardarm*" wizard. This task is accomplished through the following steps:

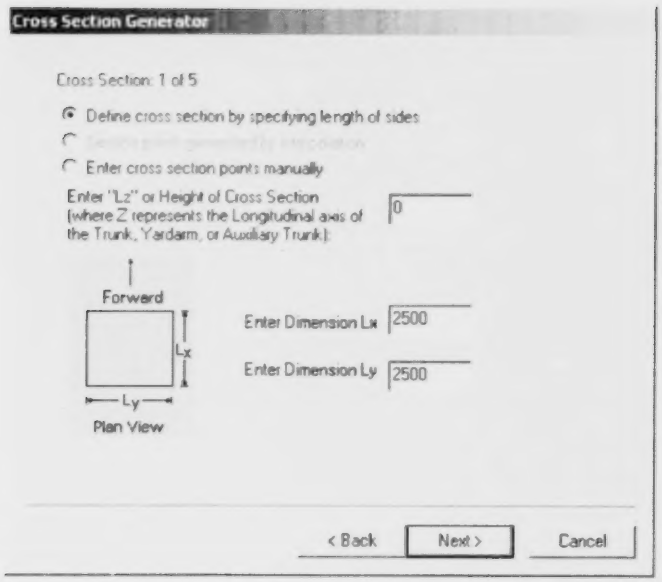
- **STEP 1**: Activate the "*Yardarm*" wizard through the "*Geometry*" tab of MASTSAS' main menu.



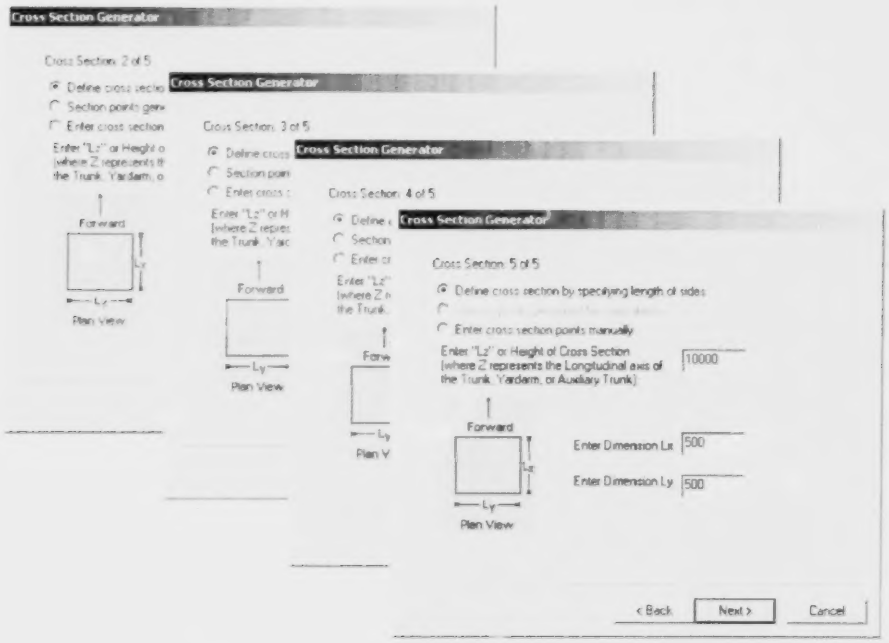
- **STEP 2**: Define the number of sides, overall length, and number of cross-sections to be used in constructing the yardarm. Select the "Next" button when completed.



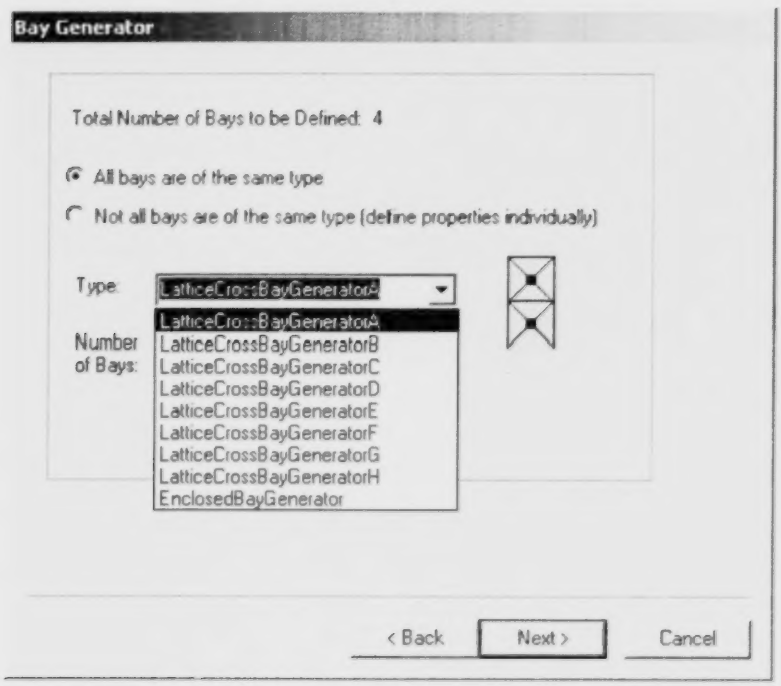
- **STEP 3**: Define the geometry for each of the cross sections specified in Step 2. Similar to the main trunk, the user may define yardarm cross section geometry using one of three methods: (i) defining the lengths of each side (common), (ii) entering the local coordinates of the cross section corner points, or (iii) defining the points using interpolation, wherein the corner points are computed by interpolating matching coordinates from neighboring cross-sections. Select the "*Next*" button when completed.



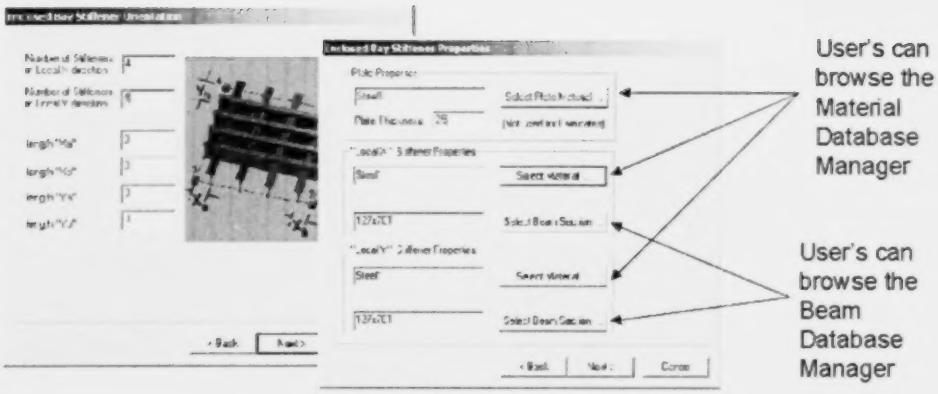
Again, the wizard will prompt the user for cross section geometry for each cross section.


Cross Section Generator
Cross Section: 5 of 5
Define cross section by specifying length of sides
Enter cross section points manually
Enter "Lz" or Height of Cross Section (where Z represents the Longitudinal axis of the Trunk, Yardarm, or Auxiliary Trunk):
10000
Forward
Enter Dimension Lx
500
Enter Dimension Ly
500
Plan View
< Back
Next >
Cancel

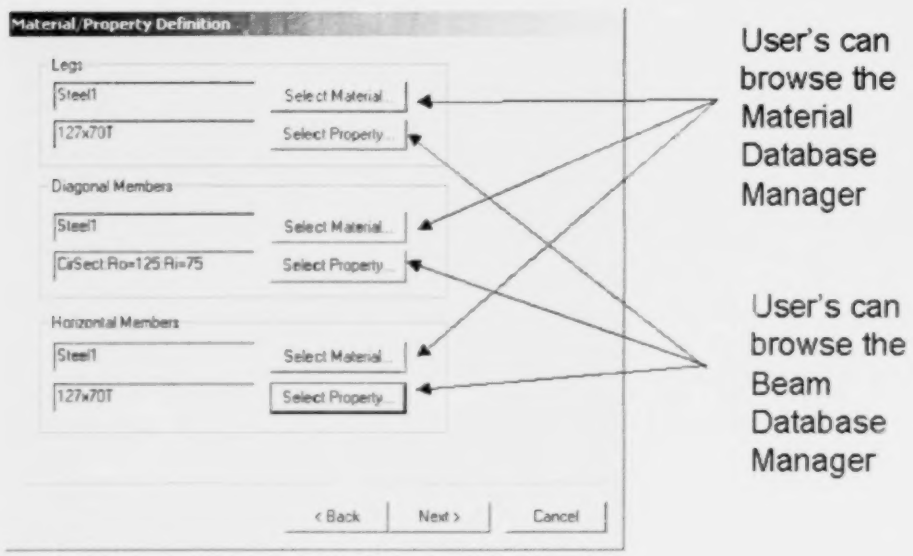
- **STEP 4**: Once all cross-sections have been defined, the wizard prompts the user for a *Bay-Generator* type to be applied. The total number of bays in a mast structure is equal to one less than the total number of cross-sections. The MASTSAS wizard provides users with two options for defining the *Bay-Generators*, namely (i) making all bays the same (all 'enclosed', for example), and (ii) selecting different *Bay-Generators* for each bay (the user may select 'lattice types' A-H or 'enclosed'). Select the "*Next*" button when completed.



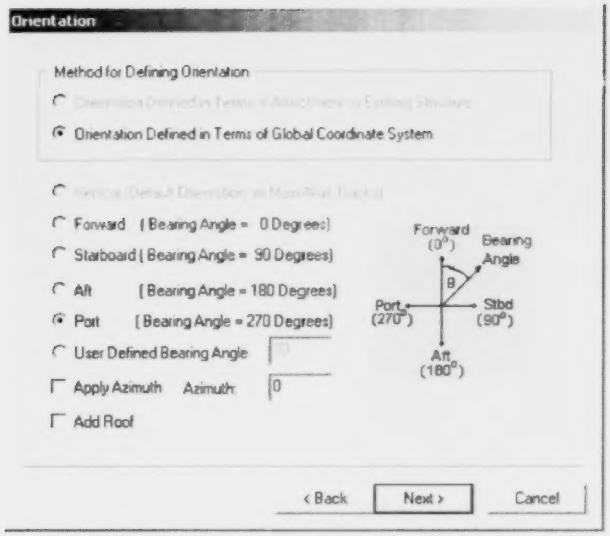
For 'enclosed' *Bay-Generators*, users must supply stiffener and material definitions. The wizard allows users to select material types using the Material Database Manager (see section 3.8), and beam sections from the Beam Database Manager (see section 3.9).



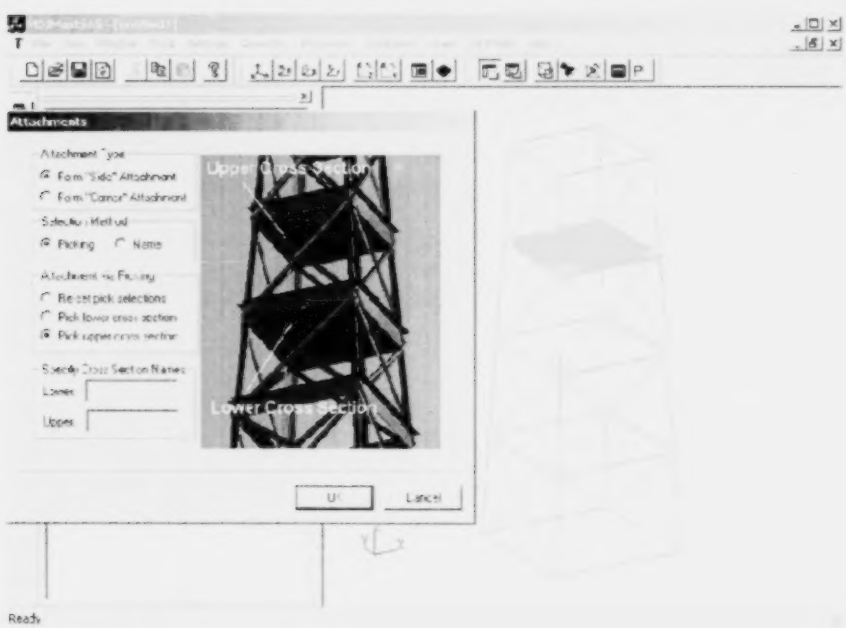
For 'lattice type' *Bay-Generators*, users are prompted for the stiffener properties of all legs, diagonal members, and horizontal members. The wizard allows users to select material types using the Material Database Manager (see section 3.8), and beam sections from the Beam Database Manager (see section 3.9).



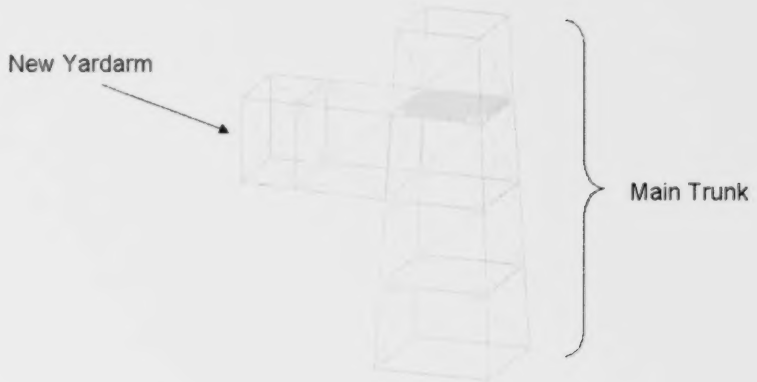
- **STEP 5**: Following the definition of the *Bay-Generator* properties, the *Yardarm* wizard then prompts the user for the orientation of the yardarm. This orientation may be defined in terms of either its attachment to existing structures or its global coordinates. Users may orient the yardarm along any angle or azimuth, and also have the option to add a '*roof* panel to the outermost cross section. The user may return to the previous menu at any time by clicking the "*Back*" button.



- **STEP 6**: In the final step, the user must specify details regarding attachment of the yardarm to the main trunk. Options include both side and corner attachments. The user simply selects the two cross-sections (i.e., upper and lower) on the existing mast structure between which the proposed yardarm will be connected. They may be selected by simply picking them or using their associated names (if applicable).



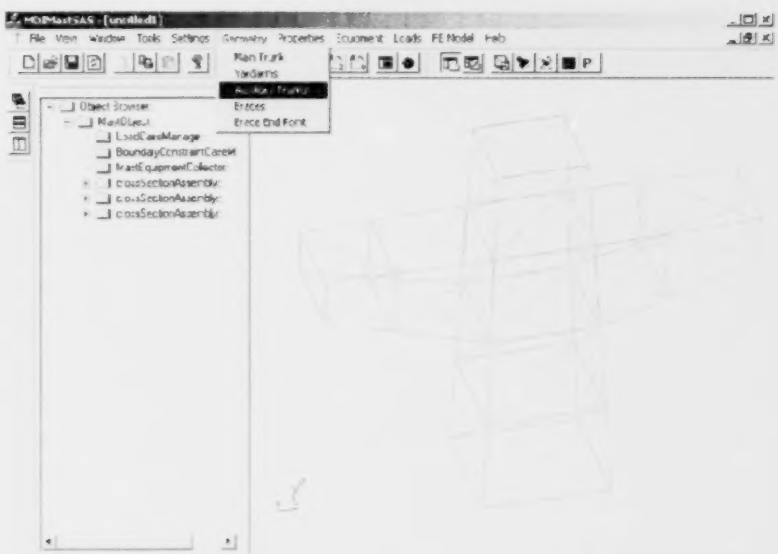
The final result is illustrated below.



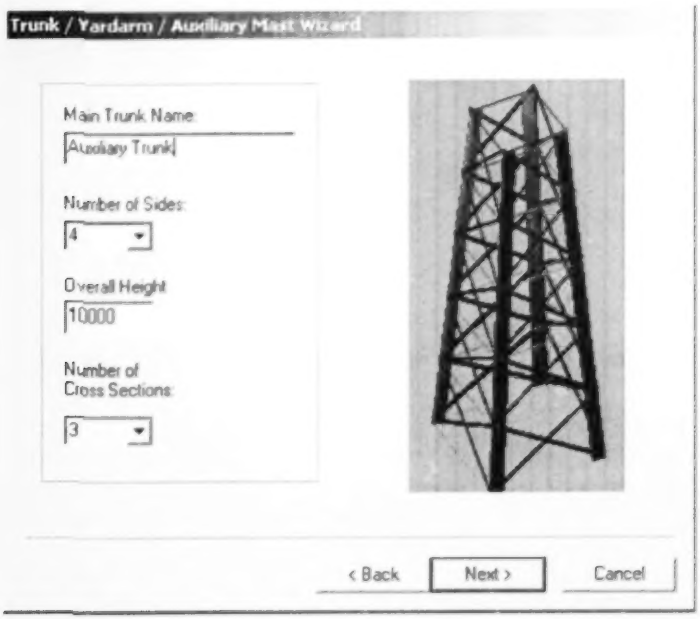
5.3 Creating and Attaching Auxiliary Trunks to Existing Mast Structures

In many cases, mast structural systems include auxiliary trunks, which are similar to the main trunk, but may be attached to existing yardarms, for example. Construction and attachment of auxiliary trunks is accomplished through the following steps:

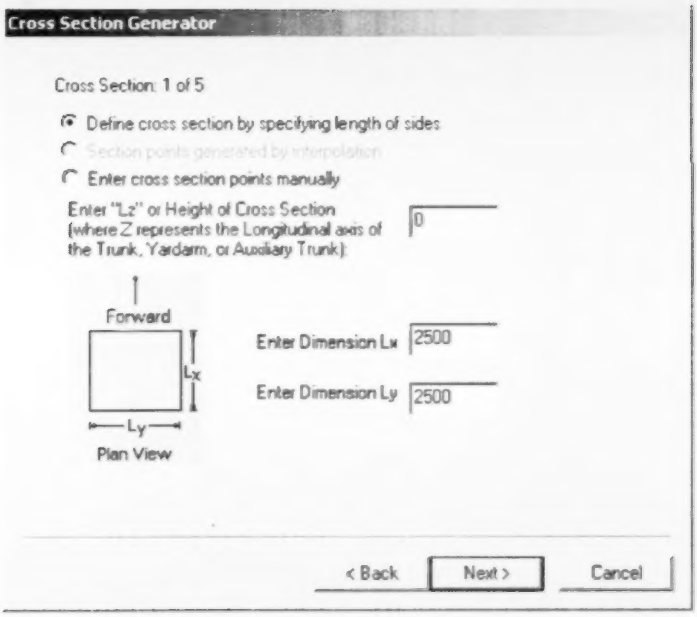
- **STEP 1**: Activate the "*Auxiliary Trunk*" wizard through the "*Geometry*" tab of MASTSAS' main menu.



- **STEP 2**: Define the number of sides, overall height, and number of cross-sections to be used in constructing the auxiliary trunk. Select the "Next" button when completed.

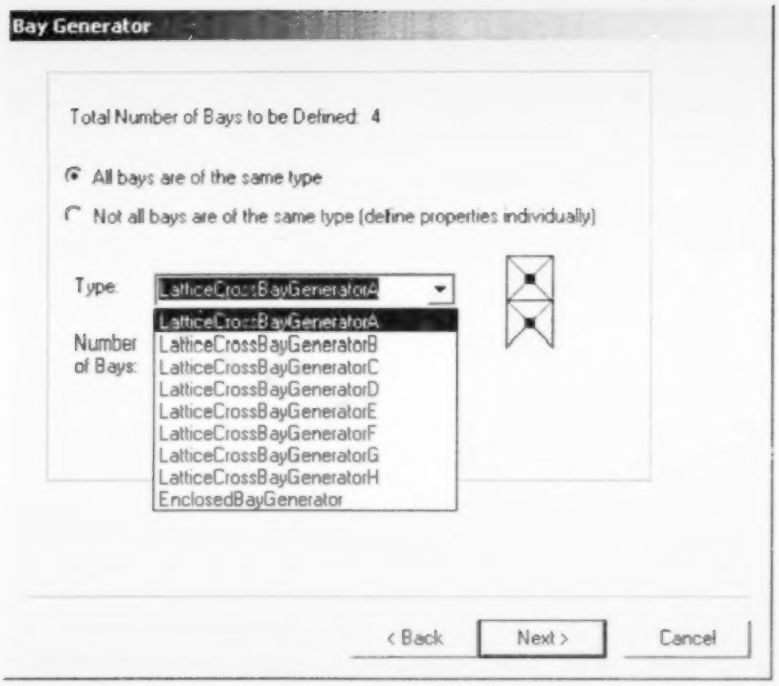


- **STEP 3**: Define the geometry for each of the cross sections specified in Step 2. The user may use one of three methods to define auxiliary trunk cross section geometry, namely: (i) defining the lengths of each side (common), (ii) entering the local coordinates of the cross section corner points, or (iii) defining the points using interpolation, wherein the corner points are computed by interpolating matching coordinates from neighboring cross-sections. Select the "*Next*" button when completed.

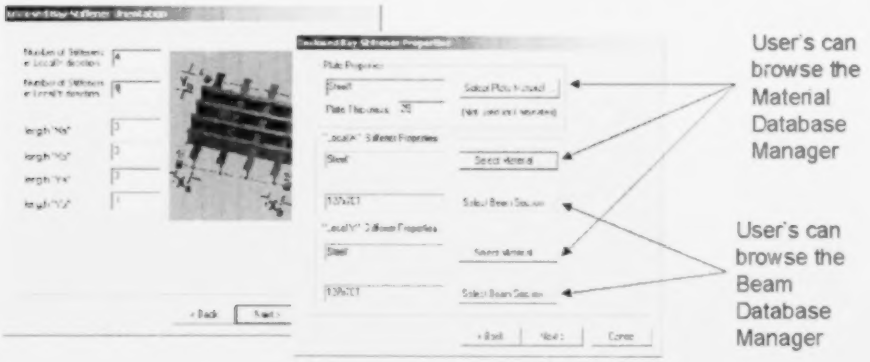


Again, the wizard will prompt the user for cross section geometry for each cross section.

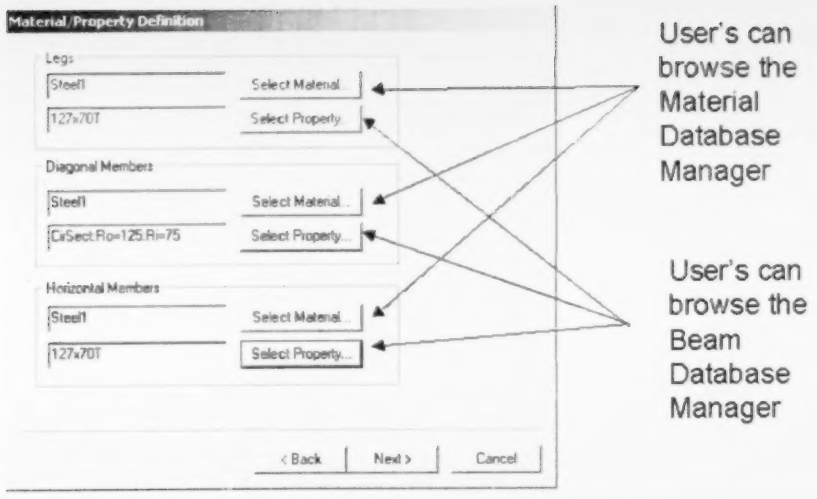
- **STEP 4**: Once all auxiliary trunk cross-sections have been defined, the wizard prompts the user for a *Bay-Generator* type to be applied. The total number of bays in a mast structure is equal to one less than the total number of cross-sections. The MASTSAS wizard provides users with two options for defining the *Bay-Generators*, namely (i) making all bays the same (all 'enclosed', for example), and (ii) selecting different *Bay-Generators* for each bay (the user may select 'lattice types' A-H or 'enclosed'). Select the "*Next*" button when completed.



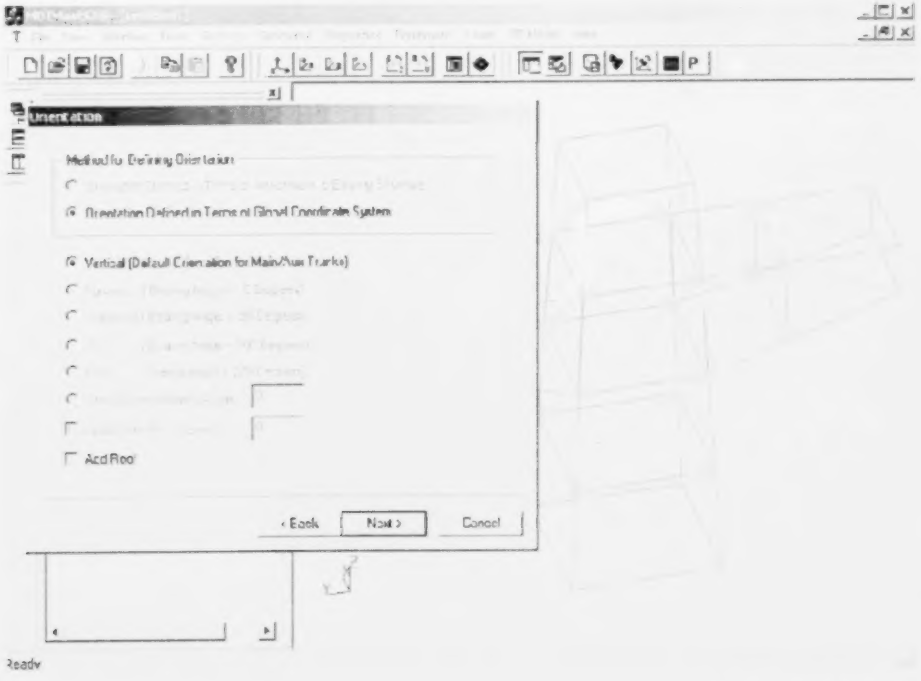
For 'enclosed' Bay-Generators, users must supply stiffener and material definitions. The wizard allows users to select material types using the Material Database Manager (see section 3.8), and beam sections from the Beam Database Manager (see section 3.9).



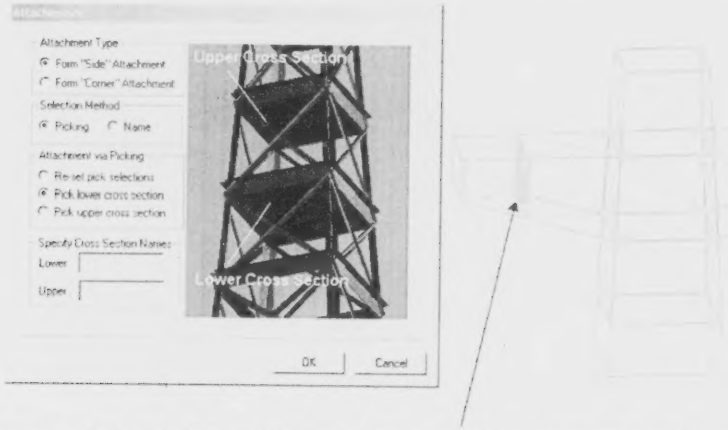
For 'lattice type' *Bay-Generators*, users are prompted for the stiffener properties of all legs, diagonal members, and horizontal members. The wizard allows users to select material types using the Material Database Manager (see section 3.8), and beam sections from the Beam Database Manager (see section 3.9).



- **STEP 5**: Once the *Bay-Generator* properties have been defined for the auxiliary trunk, the user must define its global orientation (vertical is the default). Users have the option to add a '*roof* panel to the topmost cross section. The user may return to the previous menu at any time by clicking the "*Back*" button.

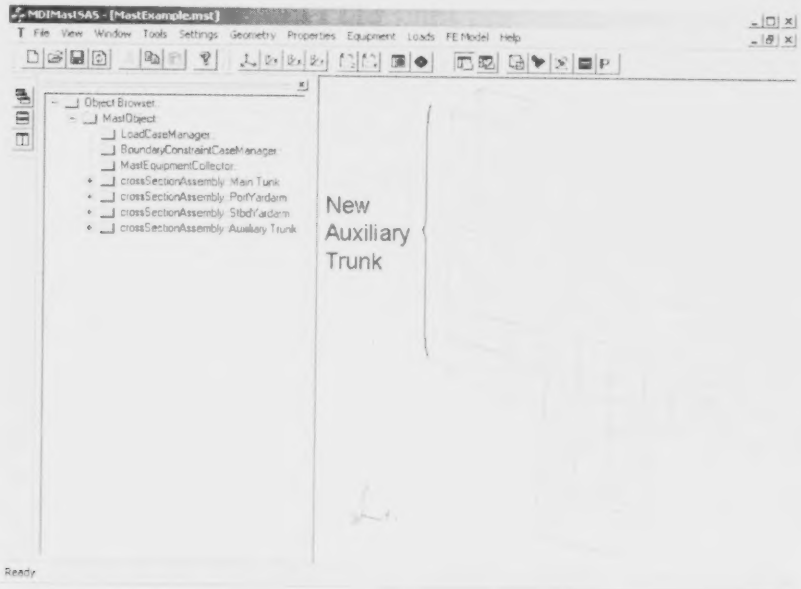


- **STEP 6**: Finally, the user must specify details regarding attachment of the auxiliary trunk to the existing mast structure. Options include both side and corner attachments. The user must select the two cross-sections (i.e., left and right) on the existing mast structure between which the proposed auxiliary trunk will be connected. They may be selected by simply picking or using associated names (if applicable).



When the user selects one of the "attachment" cross-sections, it is highlighted as a solid panel

The resulting structure, including the previously defined trunk and yardarm, is shown in the figure below.



5.4 Creating Stiffened Panels

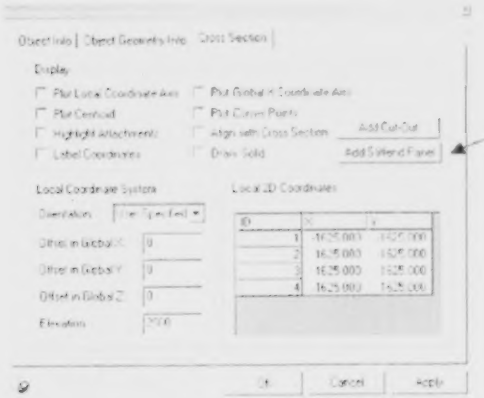
Mast cross sections are often comprised of stiffened panel sections. The following steps outline the procedure for creating stiffened panel sections using the MASTSAS software.

- **STEP 1**: Select the cross section for which a stiffened panel is to be constructed.

User's can identify the cross-section by either "picking" its graphical representation, or by selecting the cross-section from the SceneGraph tree control.

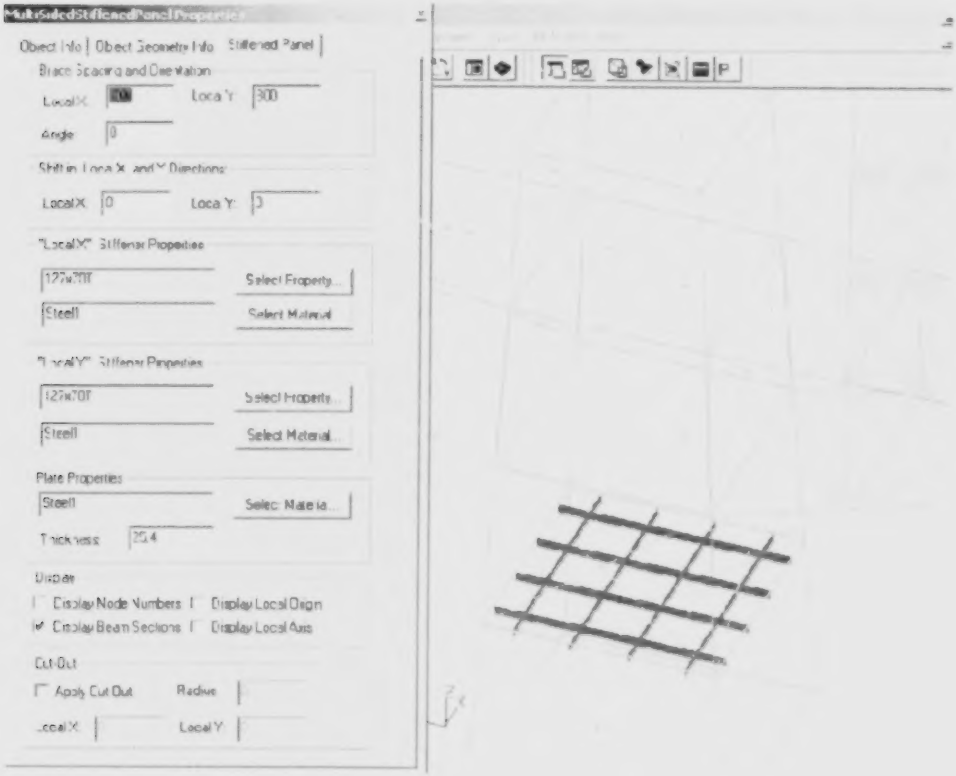
Once the cross-section has been selected, it will be drawn as a solid panel and it's property page will be displayed.

- **STEP 2**: Select the "*Add Stiffened Panel*" button located under the "*Cross Section*" tab on the property page for the selected cross-section. This will generate a new stiffened panel and display its property page.



"Add Stiffened Panel" Button

- **STEP 3**: Supply the data required by the stiffened panel property page. This includes information pertaining to brace spacing and orientation, plate/stiffener properties, and display options.



5.5 Creating Stiffened Panel Cut-outs

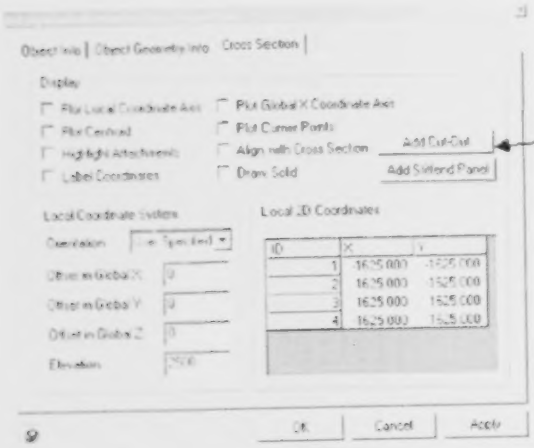
The MASTSAS software also features an option for including cutouts within stiffened panels. The following procedure outlines the creation of panel cutouts.

- **STEP 1**: Select the mast cross section for which a stiffened panel cutout is to be created.

User's can identify the cross-section by either "picking" its graphical representation, or by selecting the cross-section from the SceneGraph tree control.

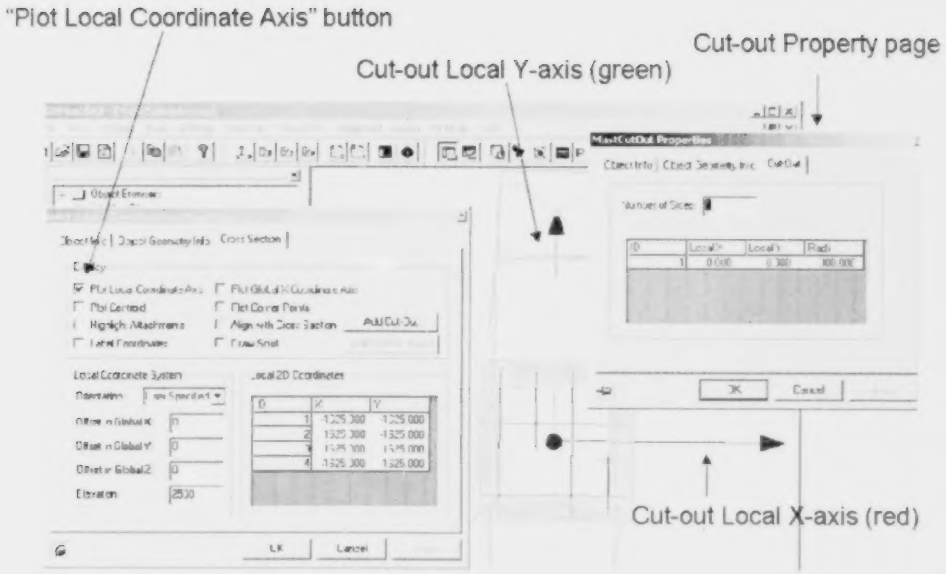
Once the cross-section has been selected, it will be drawn as a solid panel and it's property page will be displayed.

- **STEP 2**: Select the "*Add Cut-Out*" button located under the "*Cross Section*" tab on the property page for the selected cross-section. This will generate a new stiffened panel cutout and display its property page.

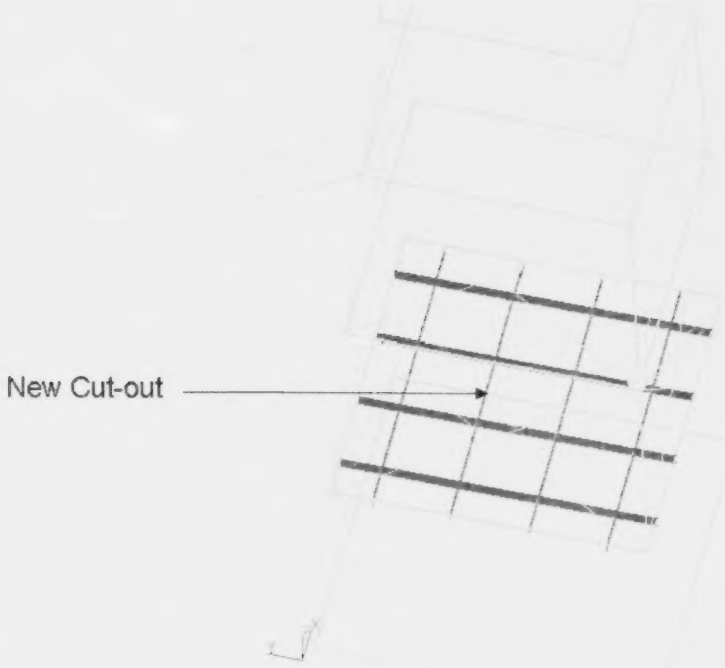


"Add Cut-Out" Button

- **STEP 3**: Stiffened panel cut-outs are defined in terms of 'corners' and 'radii'. The radii are defined in terms of the associated cross-section's 'local' coordinate system. Users can plot the local coordinate system by selecting the "*Plot Local Coordinate Axis*" button located on the cross-section property page.



The resulting mast structure, stiffened panel cutout included, is shown in the figure below.

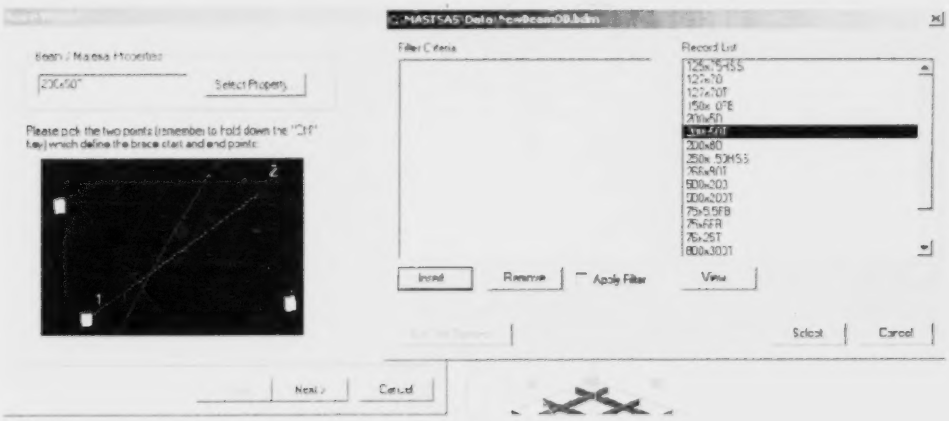


5.6 Creating Braces on An Existing Mast Structural System

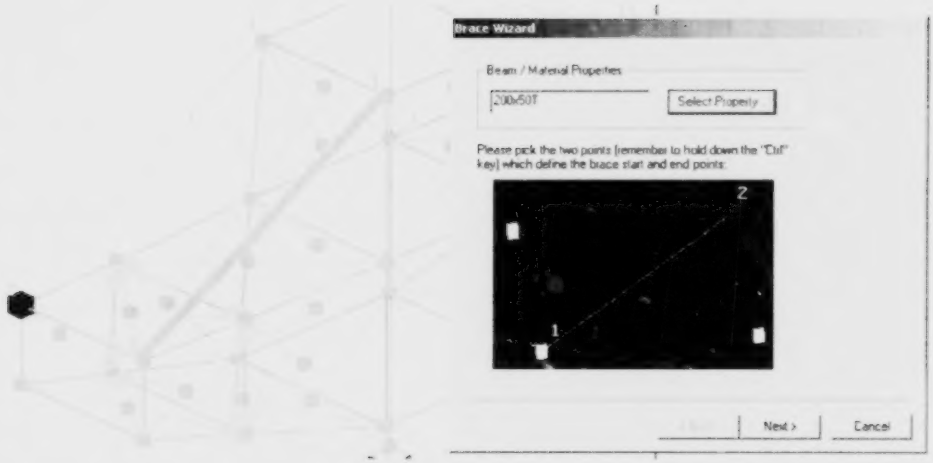
The MASTSAS software also enables the user to add braces to the mast system constructed thus far. The addition of mast bracing may be accomplished through the following procedure.

- **STEP 1**: Activate the "*Brace*" wizard through the "*Geometry*" tab on the main menu.

- **STEP 2**: Select the brace section property type. The brace wizard provides users with access to the beam property database. Users can change the brace section property type by clicking the "*Select Property*" button. Users also have access to the Beam Database Manager (see section 3.9).

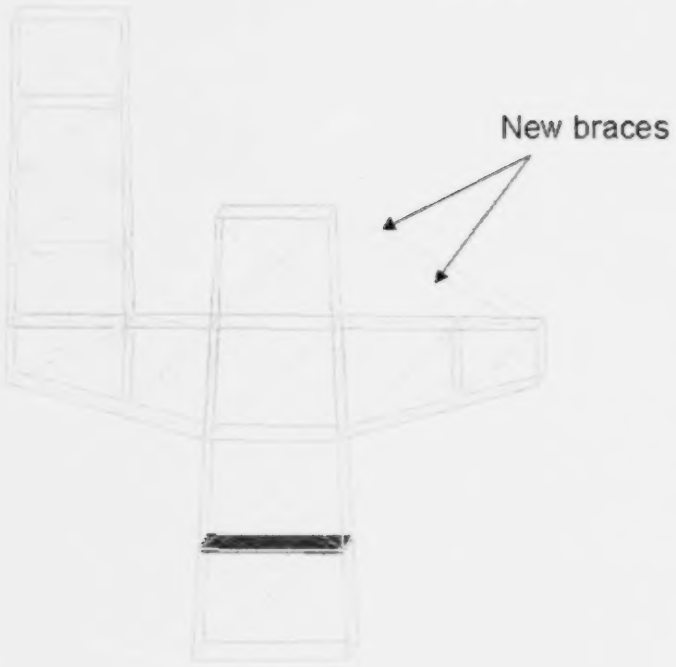


- **STEP 3**: Select the brace end-point locations by picking (i.e., place the mouse over the desired end-point location, hold down the control key, and "click" with the left mouse button.



- **STEP 4**: In the final step, the brace wizard prompts the user for the brace material type. At this time, users are given access to the material property database (see section 3.8).

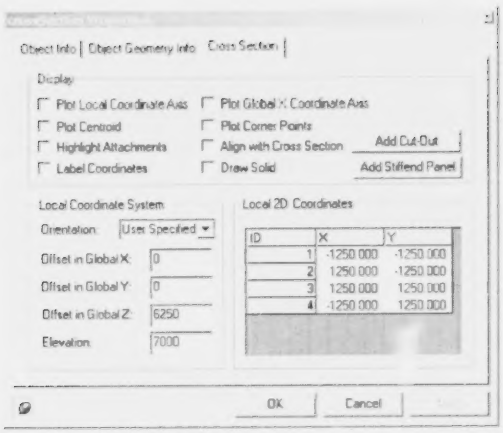
The resulting braces are shown on the mast system below.

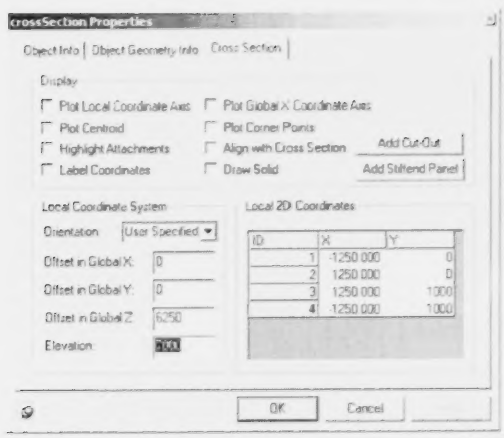


5.7 Modifying Cross Section Geometry

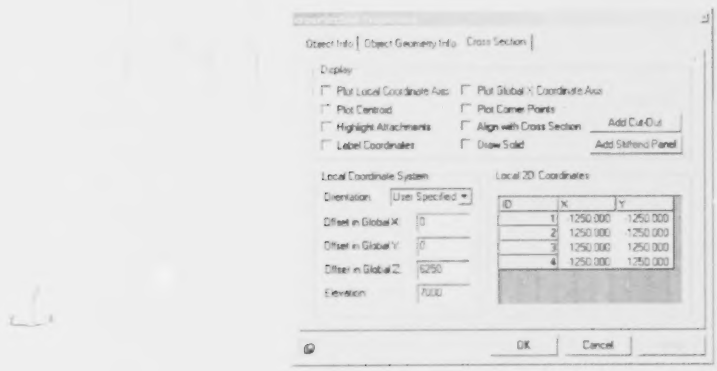
If so desired, users have the option to make modifications to the geometry of existing cross sections. Such changes may include modifications to local coordinates and/or the local coordinate system, raising or lowering the elevation of a mast system, and adding new cross sections to existing main/auxiliary trunks and yardarms. Such modifications may be performed as follows:

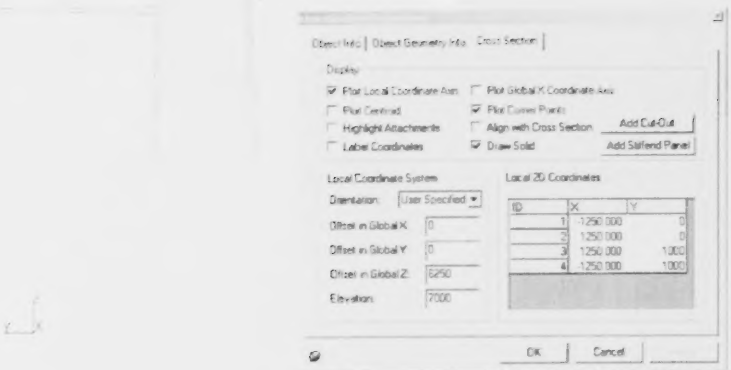
- **Modifying the Local Coordinates:** Modifying the local coordinates of a given cross-section can have a significant impact on the overall geometry of major structural components of a mast system. For example, consider the mast model shown in the figures below. Changing the local 'y' coordinates of just two points on one of the cross-sections changes the entire shape of one of the yardarms.


Object Info
Object Geometry Info
Cross Section
Display
Plot Local Coordinate Axis
Plot Global X Coordinate Axis
Plot Centroid
Plot Corner Points
Highlight Attachments
Align with Cross Section
Add Cut-Out
Label Coordinates
Draw Solid
Add Stiffend Panel
Local Coordinate System
Orientation:
User Specified
Offset in Global X:
0
Offset in Global Y:
0
Offset in Global Z:
6250
Elevation:
7000
Local 2D Coordinates
ID
X
Y
1
-1250.000
-1250.000
2
1250.000
-1250.000
3
1250.000
1250.000
4
-1250.000
1250.000
OK
Cancel

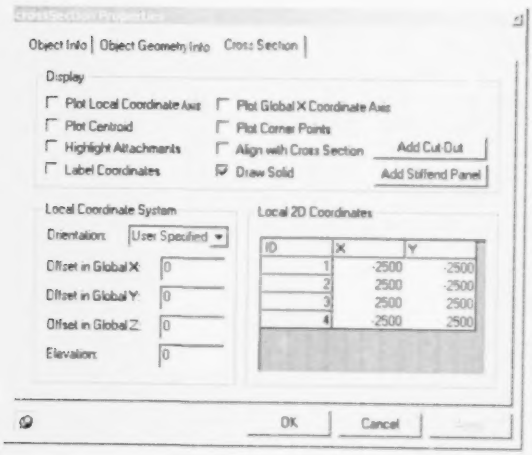

crossSection Properties
Object Info
Object Geometry Info
Cross Section
Display
Plot Local Coordinate Axis
Plot Global X Coordinate Axis
Plot Centroid
Plot Corner Points
Highlight Attachments
Align with Cross Section
Add Cut-Out
Label Coordinates
Draw Solid
Add Stiffend Panel
Local Coordinate System
Orientation:
User Specified
Offset in Global X:
0
Offset in Global Y:
0
Offset in Global Z:
6250
Elevation:
7000
Local 2D Coordinates
ID
X
Y
1
-1250.000
0
2
1250.000
0
3
1250.000
1000
4
-1250.000
1000
OK
Cancel

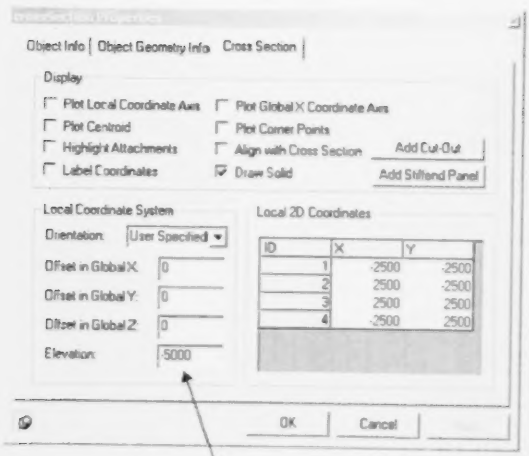
- **Modifying the Local Coordinate System**: Modifying the local coordinate system of a given cross section changes its orientation with respect to the global coordinate system. For example, consider the mast shown below. In its current form, the yardarm is pointed in the port direction (global Y direction). Modifying the local coordinate system of the cross-section highlighted in gray, as depicted in the second figure, results in a change in orientation for the entire yardarm.





- **Modifying the Elevation**: Modifying the elevation of a cross-section changes the value of its local 'z' coordinate, effectively lengthening or shortening the entire structure (including bays and braces). The effect of varying elevation is illustrated in the figures below, in which the main trunk's base cross section elevation is lowered from zero to -5000 units.



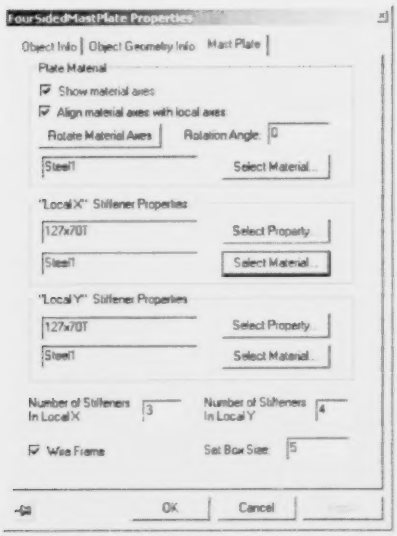


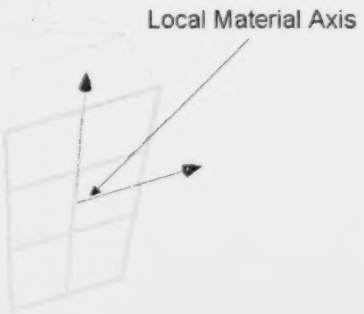
Base Elevation Reduced

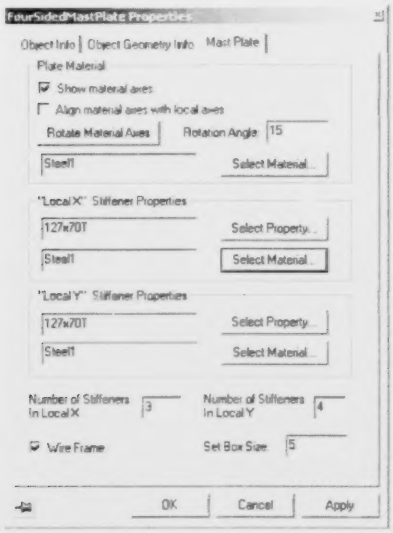
Adding a New Cross Section to an Existing Main/Auxiliary Trunk or Yardarm: New cross sections can be added to existing cross section assemblies (i.e., main trunks, auxiliary trunks, and/or yardarms) through the use of MASTSAS' "*Cross Section*" wizard. Users can activate the "*Cross Section*" wizard by first displaying the property page for the selected assembly, as shown below. The "*Cross Section*" wizard is very simple to use. It requires only that users select two existing cross-sections (which will be used to establish the shape of the new cross section) and enter the elevation for the new cross section. The addition of a new cross section is illustrated in the figures below.

5.8 Modifying Four-Sided Mast Plates

Four-sided mast plates are used to represent the sides of enclosed masts. MASTSAS users have the ability to modify the attributes of an existing four-sided mast plate, including the orientation of the local material coordinate axes, through their property pages, as illustrated in the figures below. (see Figures x.8 and x.9).

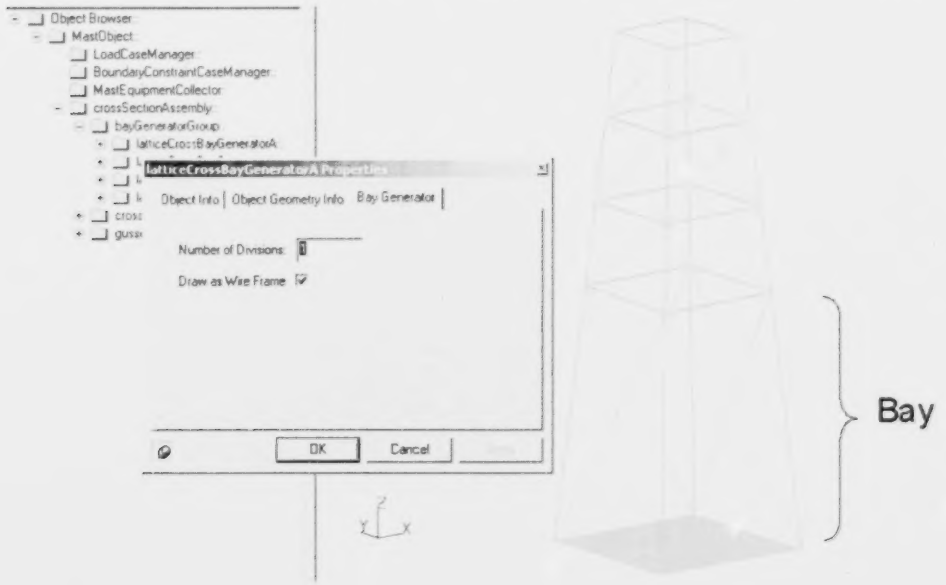


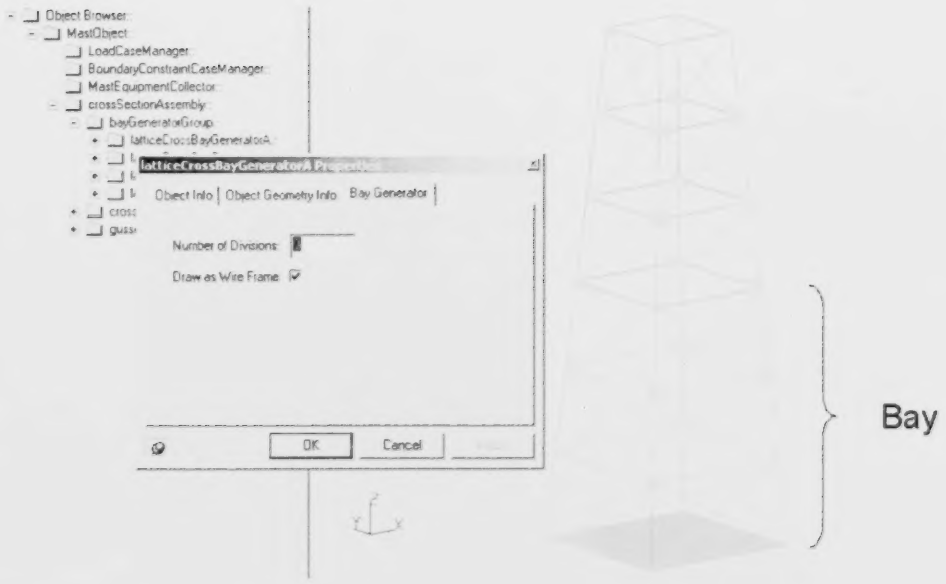




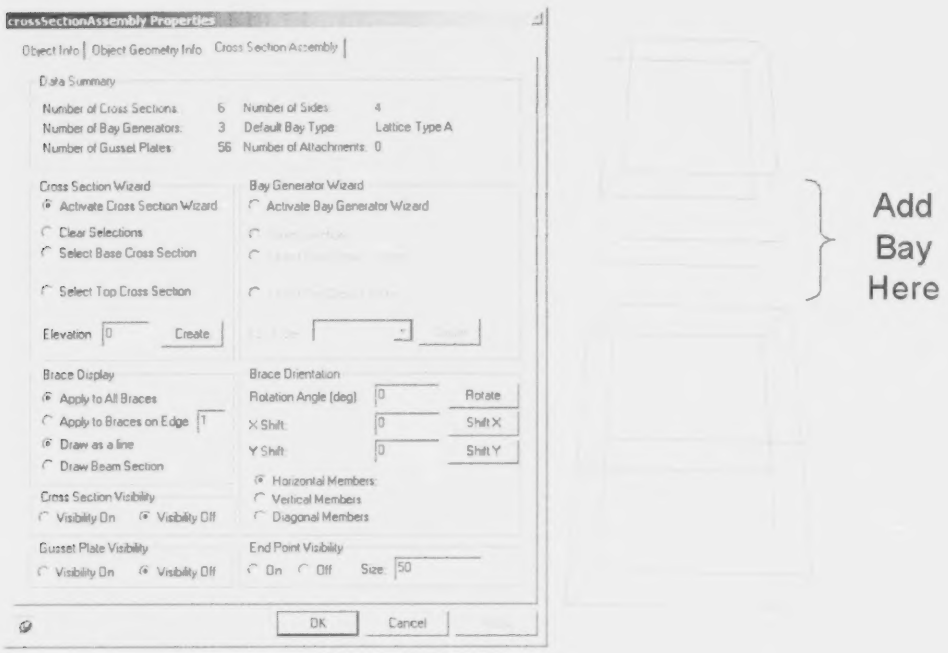
5.9 Modifying Bay Generator Properties

The property page provided for *Bay-Generators* is relatively simple, enabling users to change only the display properties and the number of bay divisions, as illustrated below.

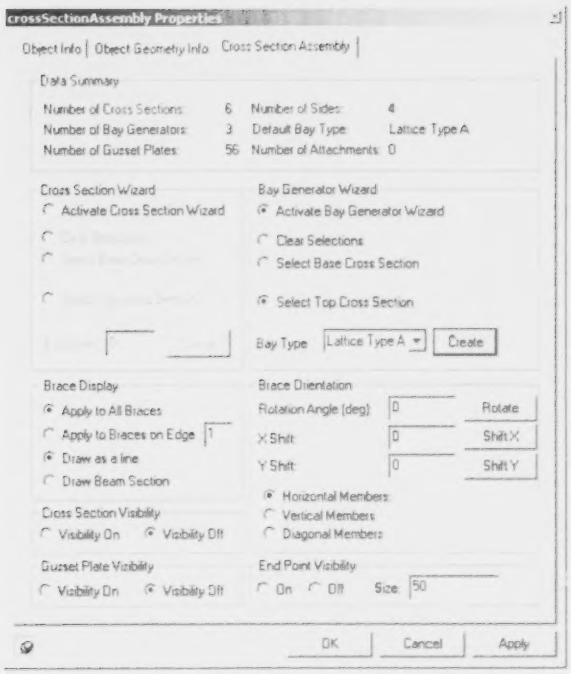


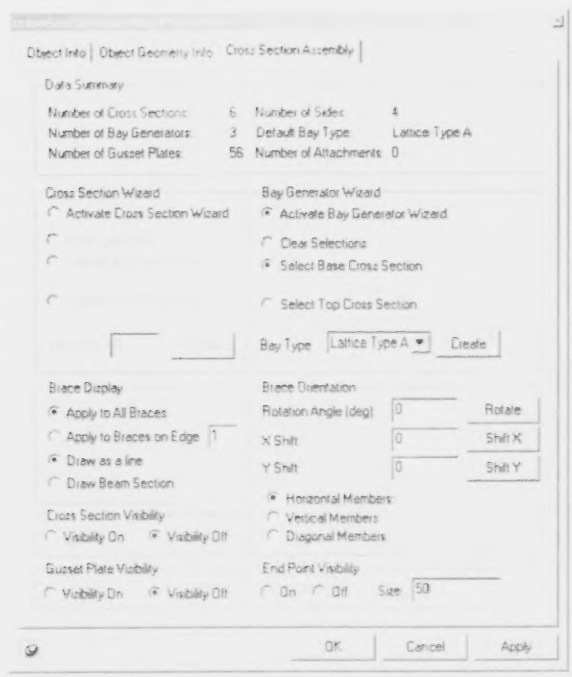


New *Bay-Generators* can also be added to existing cross-section assemblies (i.e., main/auxiliary trunks and yardarms) through the use of the *Bay-Generator* wizard. Users can activate the *Bay-Generator* wizard by first displaying the property page for the selected cross section assembly, as shown below.



The *Bay-Generator* wizard is very simple to use. It requires only that users select two existing cross-sections, which will be used to establish the shape of the new bay, and the bay type (see figures below).

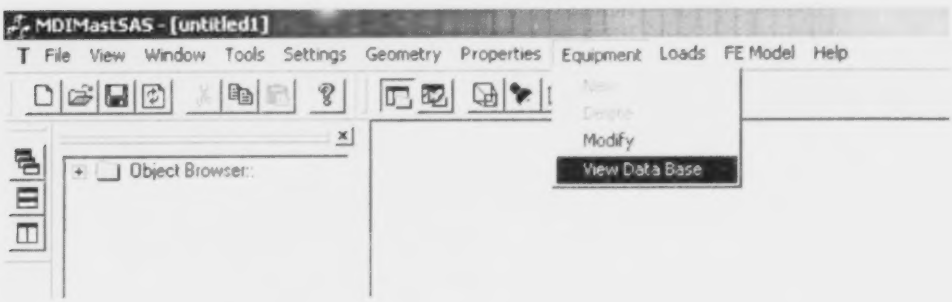

crossSectionAssembly Properties
Object Info | Object Geometry Info | Cross Section Assembly
Data Summary
Number of Cross Sections: 6
Number of Bay Generators: 3
Number of Gusset Plates: 56
Number of Sides: 4
Default Bay Type: Lattice Type A
Number of Attachments: 0
Cross Section Wizard
Activate Cross Section Wizard
Bay Generator Wizard
Activate Bay Generator Wizard
Clear Selections
Select Base Cross Section
Select Top Cross Section
Bay Type: Lattice Type A
Create
Brace Display
Apply to All Braces
Apply to Braces on Edge
Draw as a line
Draw Beam Section
Brace Orientation
Rotation Angle (deg): 0
Rotate
X Shift: 0
Shift X
Y Shift: 0
Shift Y
Horizontal Members
Vertical Members
Diagonal Members
Cross Section Visibility
Visibility On
Visibility Off
Gusset Plate Visibility
Visibility On
Visibility Off
End Point Visibility
On
Off
Size: 50
OK
Cancel
Apply


Object Info | Object Geometry Info | Cross Section Assembly
Data Summary
Number of Cross Sections: 6
Number of Bay Generators: 3
Number of Gusset Plates: 56
Number of Sides: 4
Default Bay Type: Lattice Type A
Number of Attachments: 0
Cross Section Wizard
Activate Cross Section Wizard
Bay Generator Wizard
Activate Bay Generator Wizard
Clear Selections
Select Base Cross Section
Select Top Cross Section
Bay Type: Lattice Type A
Create
Brace Display
Apply to All Braces
Apply to Braces on Edge
Draw as a line
Draw Beam Section
Brace Orientation
Rotation Angle (deg): 0
Rotate
X Shift: 0
Shift X
Y Shift: 0
Shift Y
Horizontal Members
Vertical Members
Diagonal Members
Cross Section Visibility
Visibility On
Visibility Off
Gusset Plate Visibility
Visibility On
Visibility Off
End Point Visibility
On
Off
Size: 50
OK
Cancel
Apply

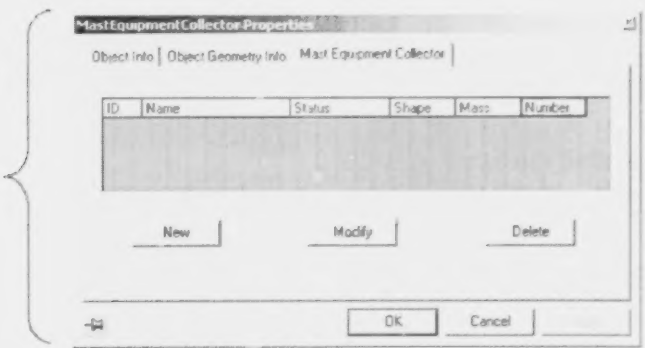
6. ATTACHING EQUIPMENT

The MASTSAS code provides user's with a capability for defining and attaching equipment to a mast model. The steps required to perform this task are provided in the sections below.

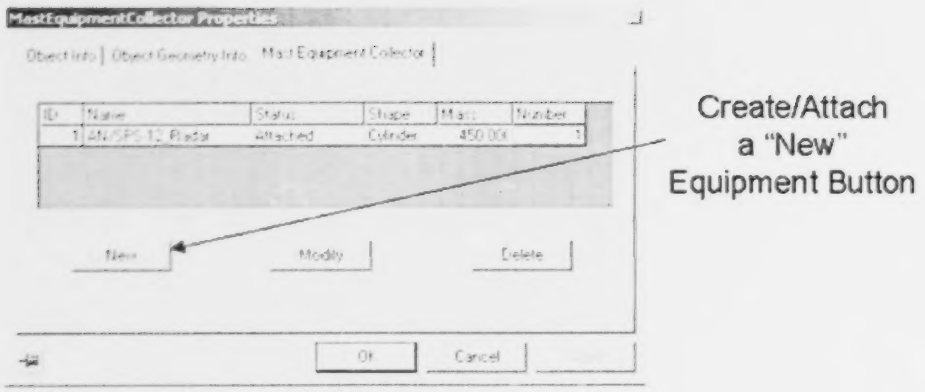
- **STEP 1**: Activate the Equipment Manager by Selecting the "*View Data Base*" option provided under the main menu's "*Equipment*" tab.


MDIMastSAS - [untitled1]
File View Window Tools Settings Geometry Properties Equipment Loads FE Model Help
Modify
View Data Base
Object Browser::

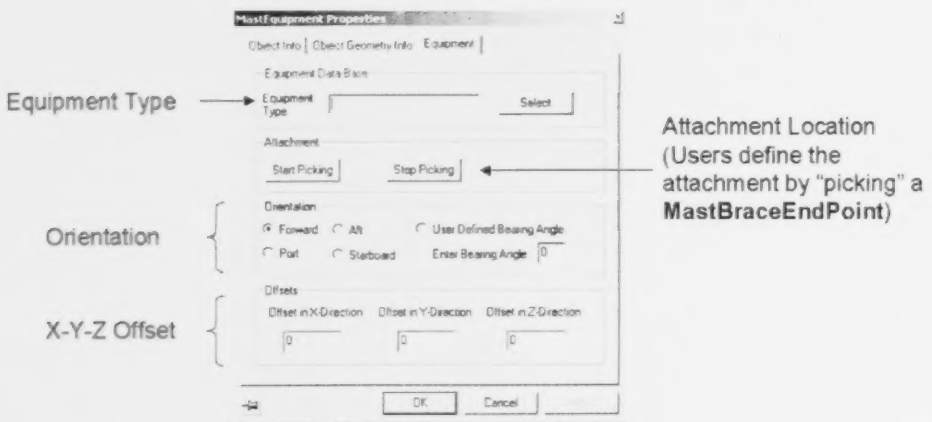
Equipment Manager Property Page



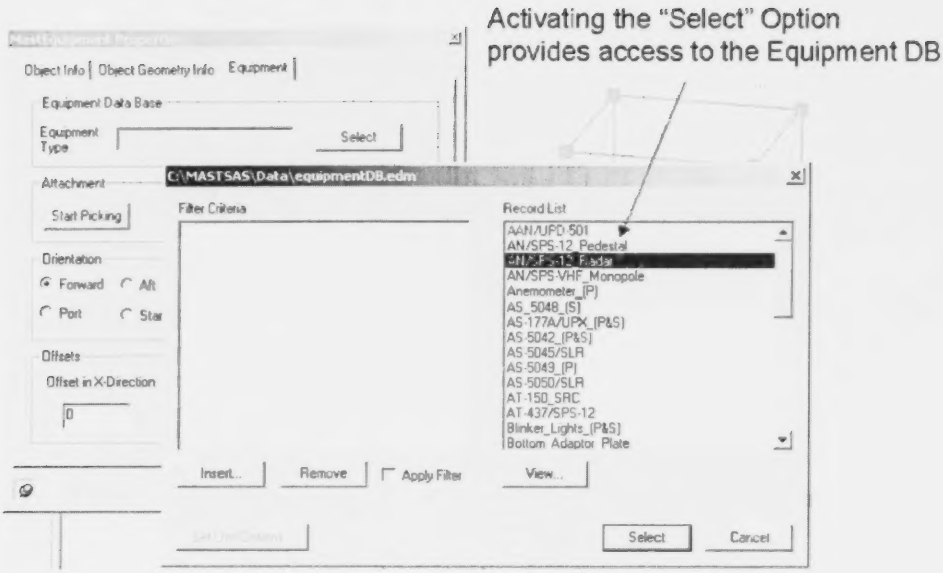
- **STEP 2**: From the *Mast Equipment Property* page, create the new equipment object to be attached to the mast.



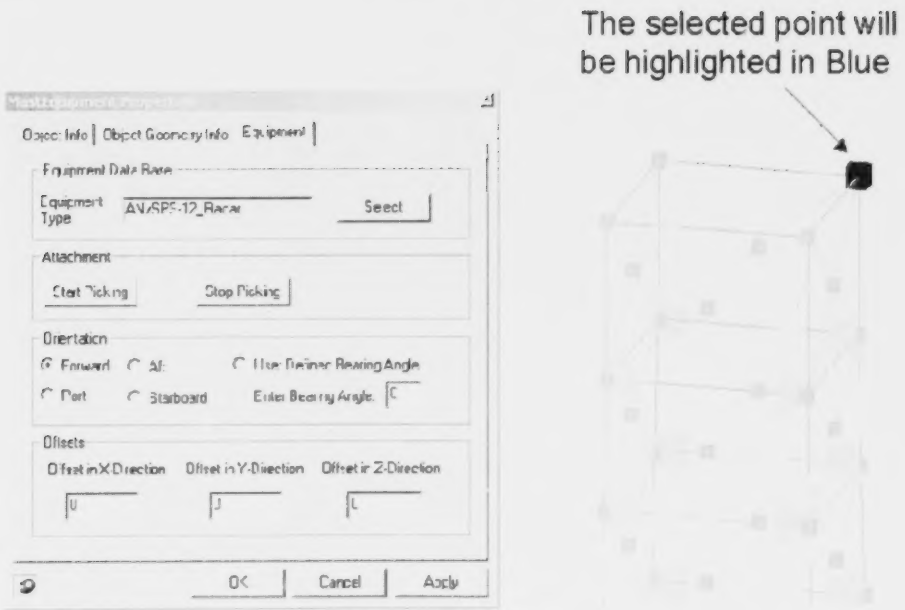
- **STEP 3**: Once the user has selected the "*New*" option to create new equipment, MASTSAS will display the property page for the new piece of equipment. From this property page, users can define the attachment point, orientation, offset, and equipment type.



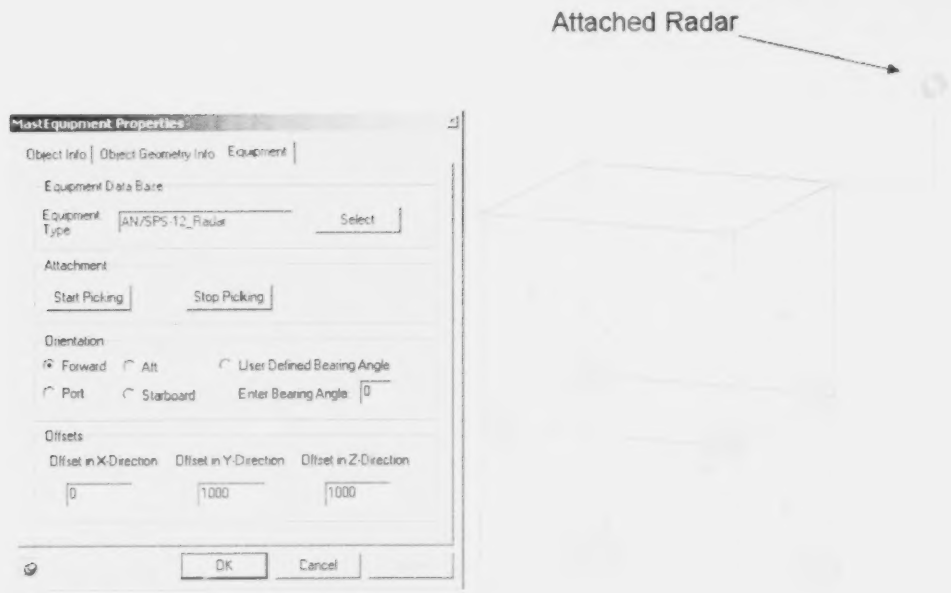
MASTSAS provides users with access to an Equipment database from which to select the appropriate equipment type.



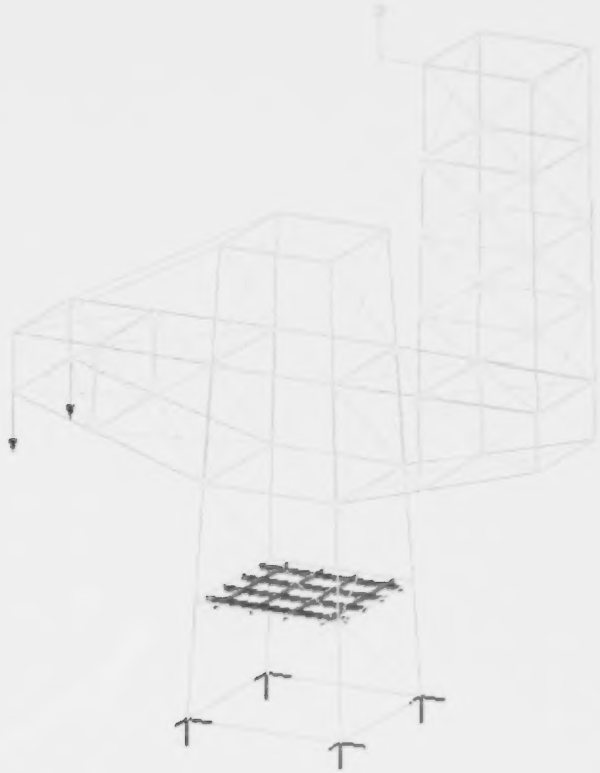
- **STEP 4**: Once the equipment type has been defined, users can then attach the new equipment object to the mast by completing the following steps:
  - (i) "click" the "*Start Picking*" button,
  - (ii) place the mouse over the **MastBraceEndPoint** representing the equipment attachment location,
  - (iii) "click" the left-mouse button on the attachment point while holding down the "ctrl" key, and finally
  - (iv) complete the selection process by "clicking" the "*Stop Picking*" button.



- **STEP 5**: Following the attachment, the new piece of equipment will shown on the screen.



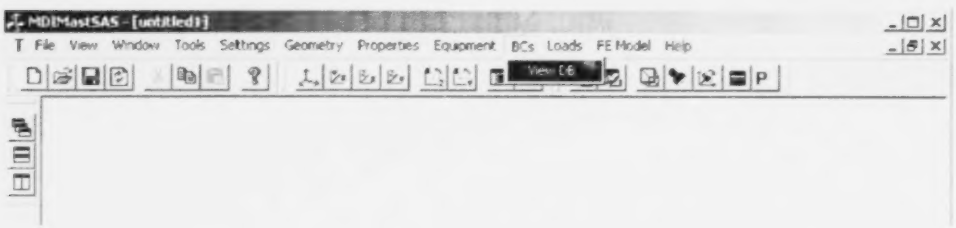
The completed mast model with attached radar is shown below.



7. CREATING AND APPLYING BOUNDARY CONDITIONS

Before the mast system can be analyzed, suitable boundary conditions must be applied to ensure that all likely in-situ restraints against displacement, rotation, etc. are properly accounted for.

- **STEP 1**: Display the **BoundaryConstraintCaseManager** property page by selecting the "*View DB*" option provided under the "*BCs*" tab of the main menu.



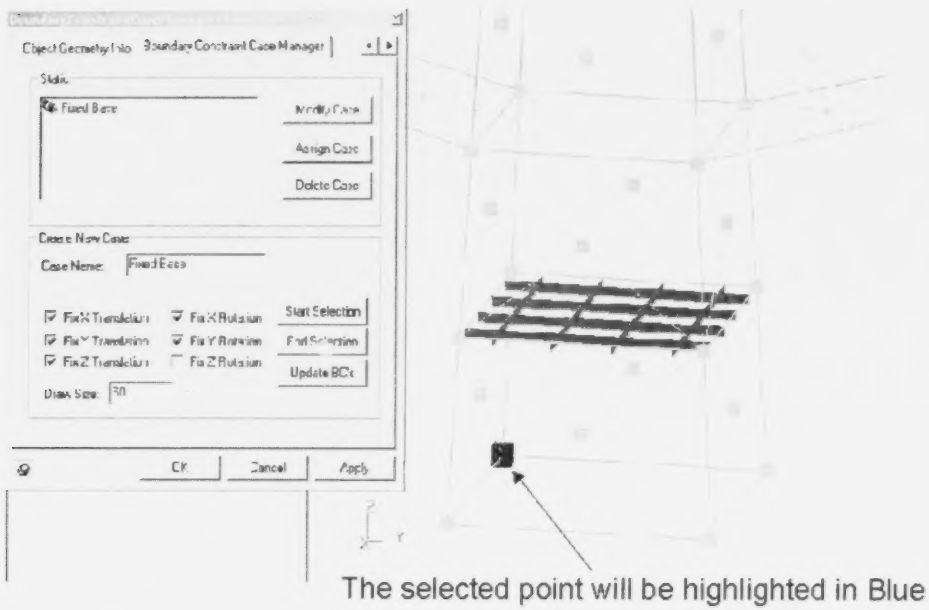
- **STEP 2**: The **BoundaryConstraintCaseManager** property page allows users to create, modify, and/or delete a series of different 'boundary constraint cases'. MASTSAS users can create a new boundary constraint case by filling in the data fields provided in the "*Create New Case*" section of the property page.

- **STEP 3**: Once the user has completed the data entry, the new boundary conditions are prescribed to geometric 'end points' by completing the following steps:
  - (i) "click" the "*Start Selection*" button.

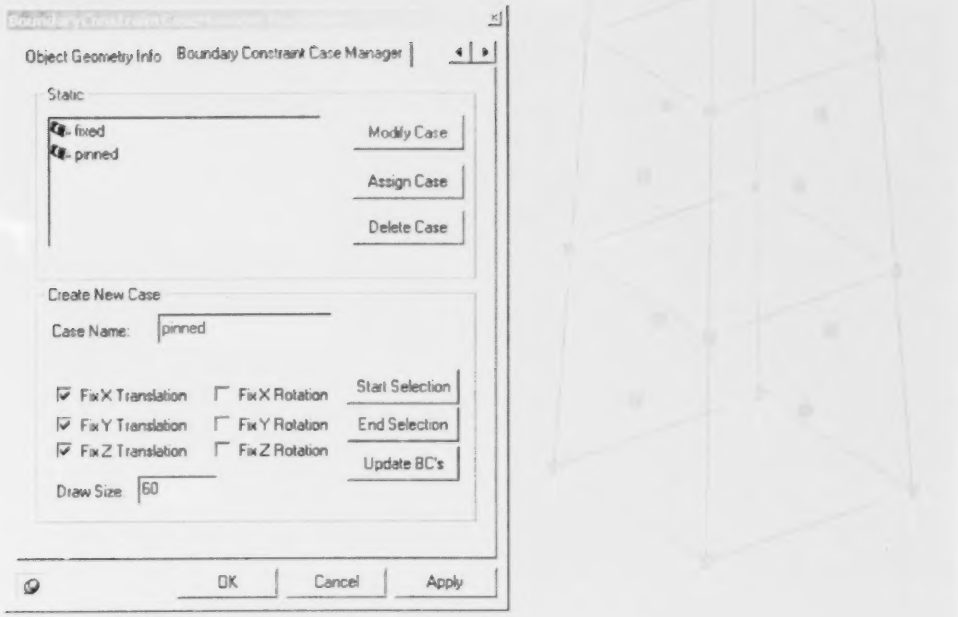
(ii) place the mouse over the MastBraceEndPoint representing the point where the boundary condition is to be applied

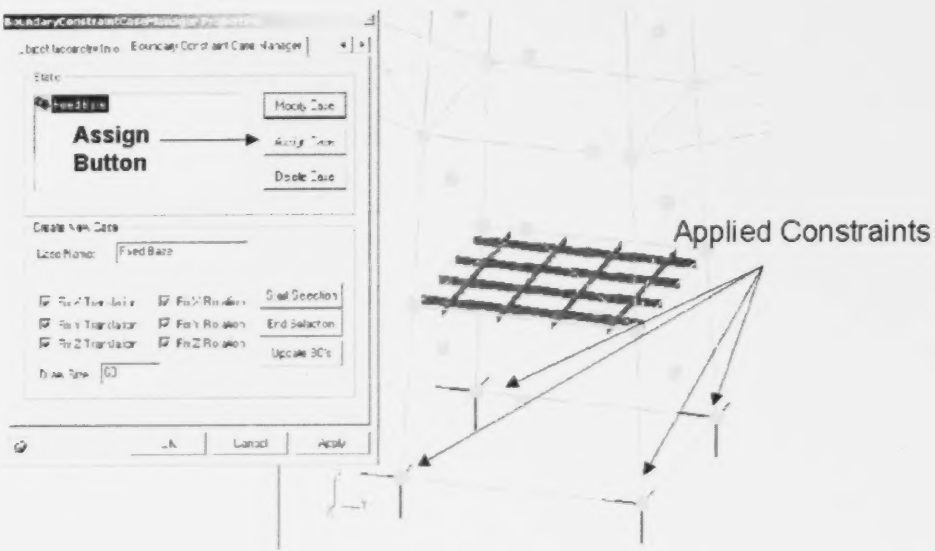
(iii) "click" the left-mouse button on the attachment point while holding down the "ctrl" key, and finally

(iv) once all points where the boundary conditions are to be applied have been selected, complete the "picking" process by "clicking" the "*End Selection*" button.



- **STEP 4**: Following the selection/definition process, users can view the new boundary condition case by making the new case the 'active case'. In order to make a boundary condition case active, the user must select the case's name from the list provided on the **BoundaryConstraintCaseManager** property page, and then select the "*Assign Button*". MASTSAS' constraint plotting notation is as follows: translational constraints are plotted as white lines, rotational constraints are plotted as black lines, and degrees of freedom having both translations and rotations fixed are plotted as red lines

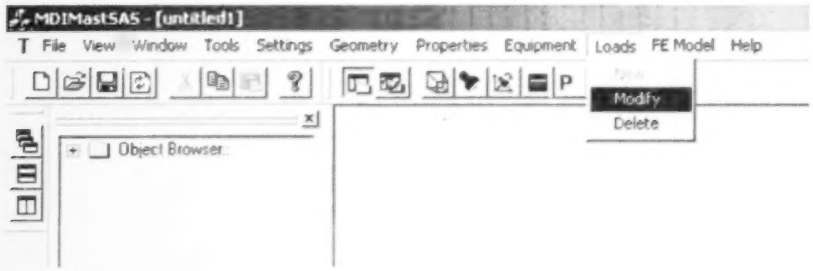

Object Geometry Info
Boundary Constraint Case Manager
Static
fixed
pinned
Modify Case
Assign Case
Delete Case
Create New Case
Case Name:
pinned
Fix X Translation
Fix Y Translation
Fix Z Translation
Fix X Rotation
Fix Y Rotation
Fix Z Rotation
Start Selection
End Selection
Update BC's
Draw Size:
60
OK
Cancel
Apply


Assign
Button
Applied Constraints

8. CREATING AND APPLYING LOADS

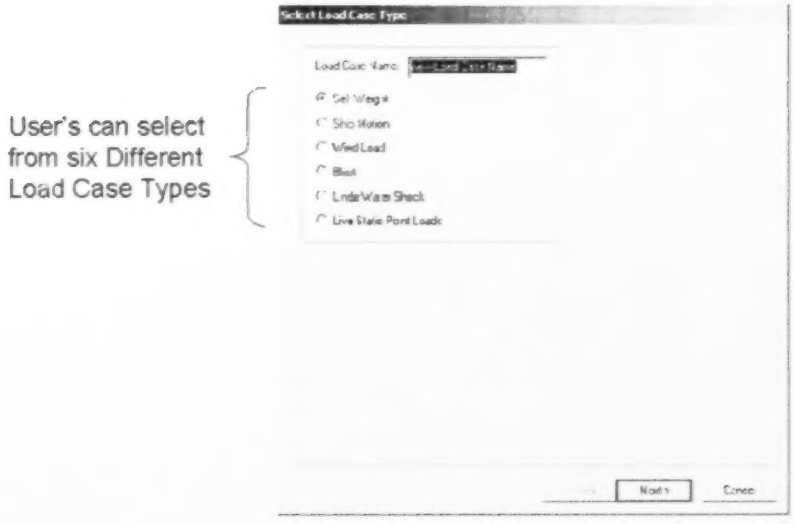
In addition to applying proper boundary conditions to a mast model, the creation and application of applicable loads constitutes one of the most important facets of structural modeling. MASTSAS users have the option of applying loads due to self-weight, ship motion, wind, blast, underwater shock, and live loads. The creation and application of mast loading is described via the following step-by-step procedure.

- **STEP 1**: Display the **LoadCaseManager** property page by selecting the "*Modify*" option provided under the "*Loads*" tab of the main menu.



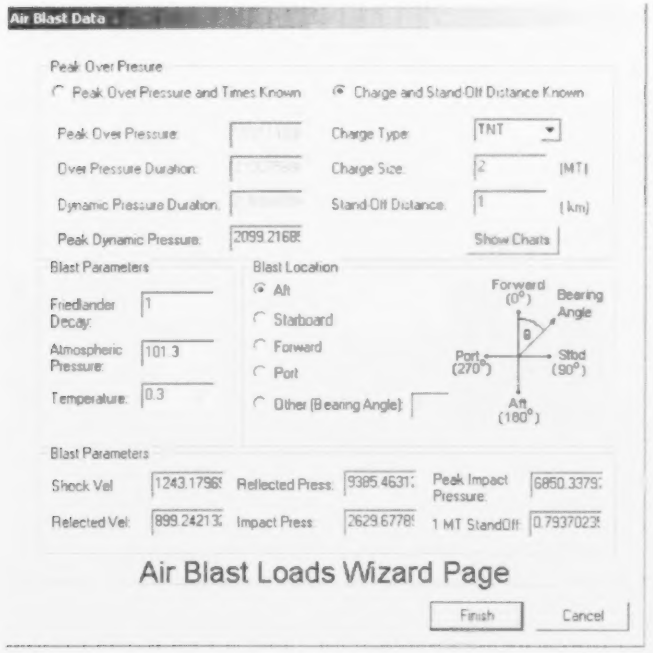
- **STEP 2**: The **LoadCaseManager** property page allows users to create, modify, and/or delete a series of different 'load cases'. Users can create a new load case simply by selecting "*New Case*" button.

- **STEP 3**: Upon selection of the "*New Case*" option, MASTSAS invokes a '*Load Case*' wizard, which guides the user through the step required to create a new load case. The wizard can be used to create up to six different load types, including self-weight, ship motion loads, wind loads, blast loads, underwater shock loads, and live static loads.



- **STEP 4**: Once the user has selected the type of load to be created, the *Load Case* wizard prompts the user for detailed information specific to the selected load type.

Wind Load Data
Wind Speed: 10 Knots
Air Density: 1.2e-009 kg/mm3
Wind Direction
Aft
Starboard
Forward
Port
Other: Enter Bearing Angle: 0
Forward (0°)
Bearing Angle
θ
Port (270°)
Stbd (90°)
Aft (180°)
Wind Loads Wizard Page
Finish
Cancel

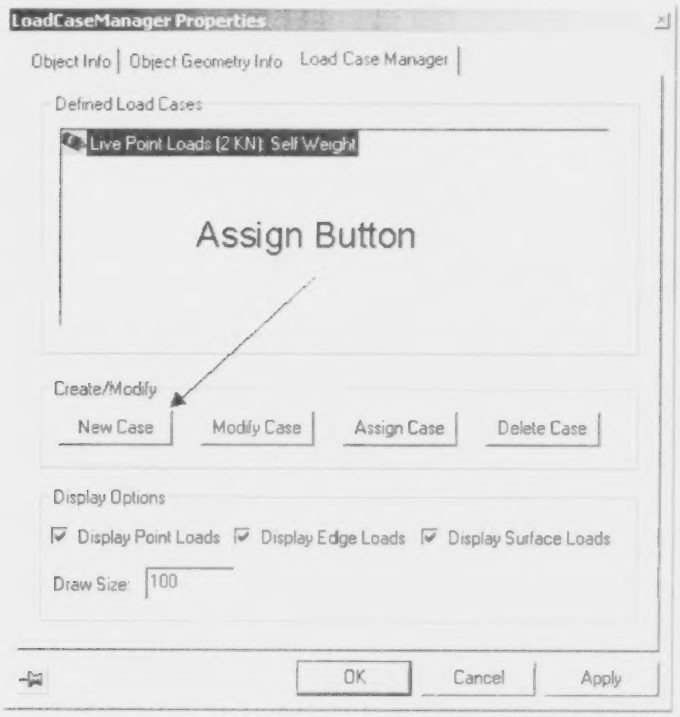

Air Blast Data
Peak Over Pressure
Peak Over Pressure and Times Known
Charge and Stand Off Distance Known
Peak Over Pressure:
Over Pressure Duration:
Dynamic Pressure Duration:
Peak Dynamic Pressure: 2099.2168
Charge Type: TNT
Charge Size: 2 (MT)
Stand Off Distance: 1 (km)
Show Charts
Blast Parameters
Friedlander Decay: 1
Atmospheric Pressure: 101.3
Temperature: 0.3
Blast Location
Aft
Starboard
Forward
Port
Other (Bearing Angle):
Forward (0°)
Bearing Angle
θ
Port (270°)
Stbd (90°)
Aft (180°)
Blast Parameters
Shock Vel: 1243.1796
Reflected Press: 9385.4631
Peak Impact Pressure: 6850.3379
Reflected Vel: 899.24213
Impact Press: 2629.6778
1 MT StandOff: 0.7937023
Air Blast Loads Wizard Page
Finish
Cancel

For cases involving the creation of live loads, users must attach the load to a geometric object, as shown below.

Once the user has completed the data entry, the new load case data can be applied to geometric 'end points' or 'plates' by performing the following tasks:

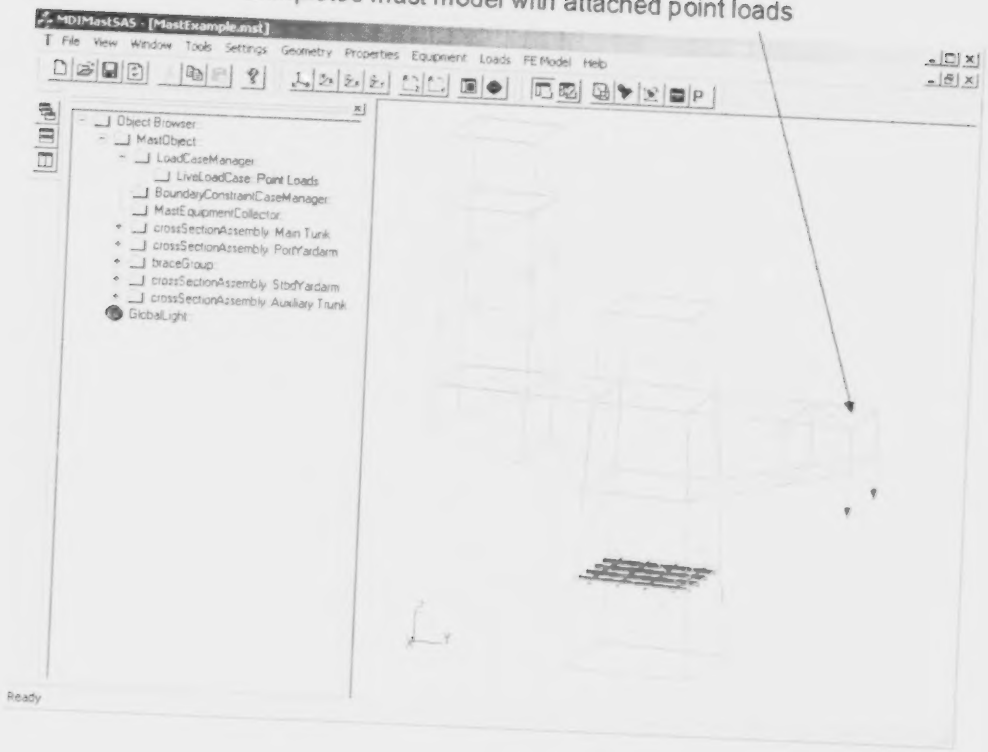
(i) select either surface or point loads,
(ii) fill in the load information (i.e., point load, moment, or pressure),
(iii) "click" the "*Start Picking*" button,
(iv) place the mouse over the geometric object representing the location where the load is to be applied,
(v) "click" the left-mouse button on the object while holding down the "ctrl" key, and finally
(vi) once all load application points have been selected, complete the "picking" process by "clicking" the "*Stop Picking*" button.

- **STEP 5**: Upon completion of the selection/definition process, users can view the new load case by making the new case the 'active case'. In order to make a load case active, the user must select the case's name from the list provided on the **LoadCaseManager** property page, and then select the "*Assign Button*".



The resulting mast model, complete with mast geometry and applied loading, is illustrated in the figure below.

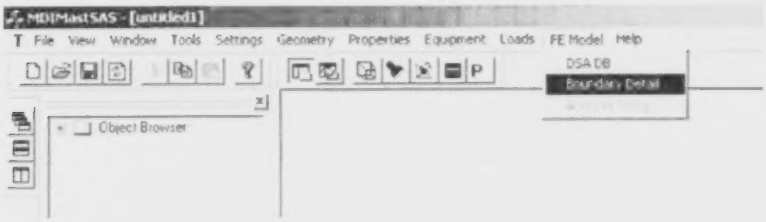
Completed mast model with attached point loads



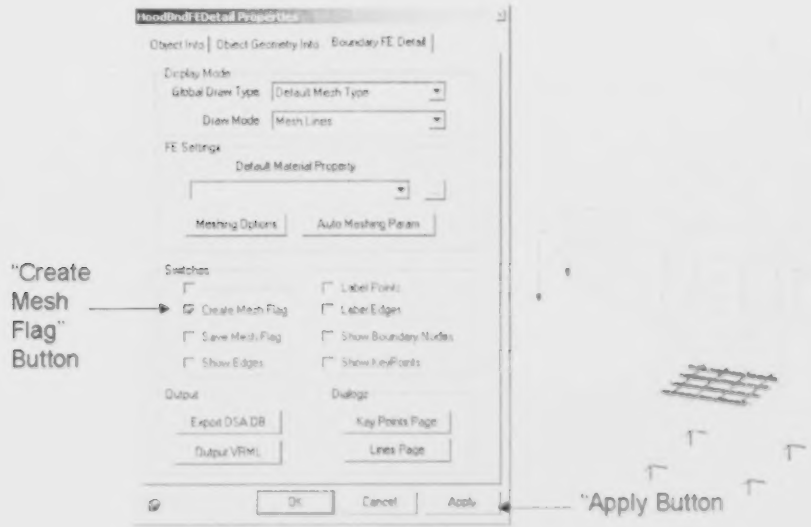
9. FINITE ELEMENT MESH GENERATION AND ANALYSIS SETUP

Generation of the finite element mesh of the mast system is relatively simple using the MASTSAS software, as is the FE analysis preparation. MASTSAS currently supports the DSA/VAST and ANSYS finite element packages. FE mesh generation and analysis setup is accomplished using the following step-by-step procedure.

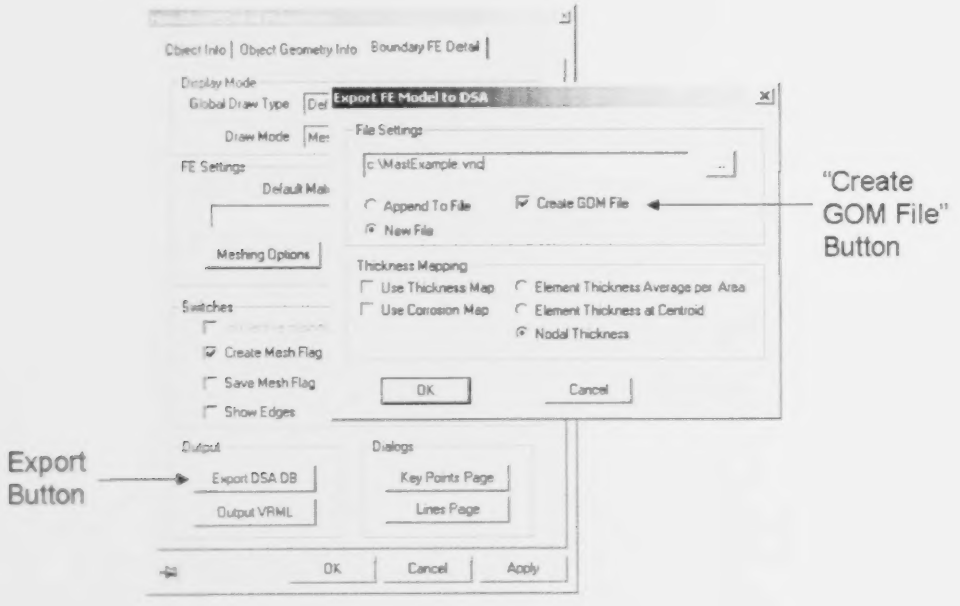
- **STEP 1**: Create a finite element boundary detail by selecting the "*Boundary Detail*" option provided under the main menu's "*FE Model*" tab.


MDIMastSAS - [untitled1]
File View Window Tools Settings Geometry Properties Equipment Loads FE Model Help
DSA DB
Boundary Detail
Object Browser

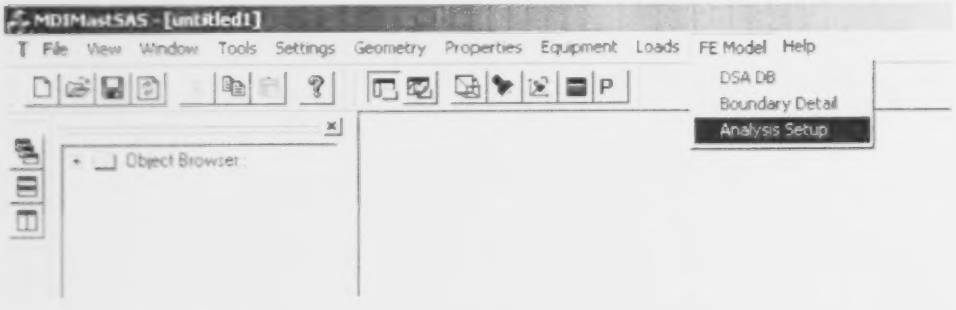
- **STEP 2**: Once the boundary detail has been created, MASTSAS will display its property page. Users can then generate a finite element mesh representing a geometric model of the mast by selecting the "*Create Mesh Flag*", followed by the "*Apply*" button.



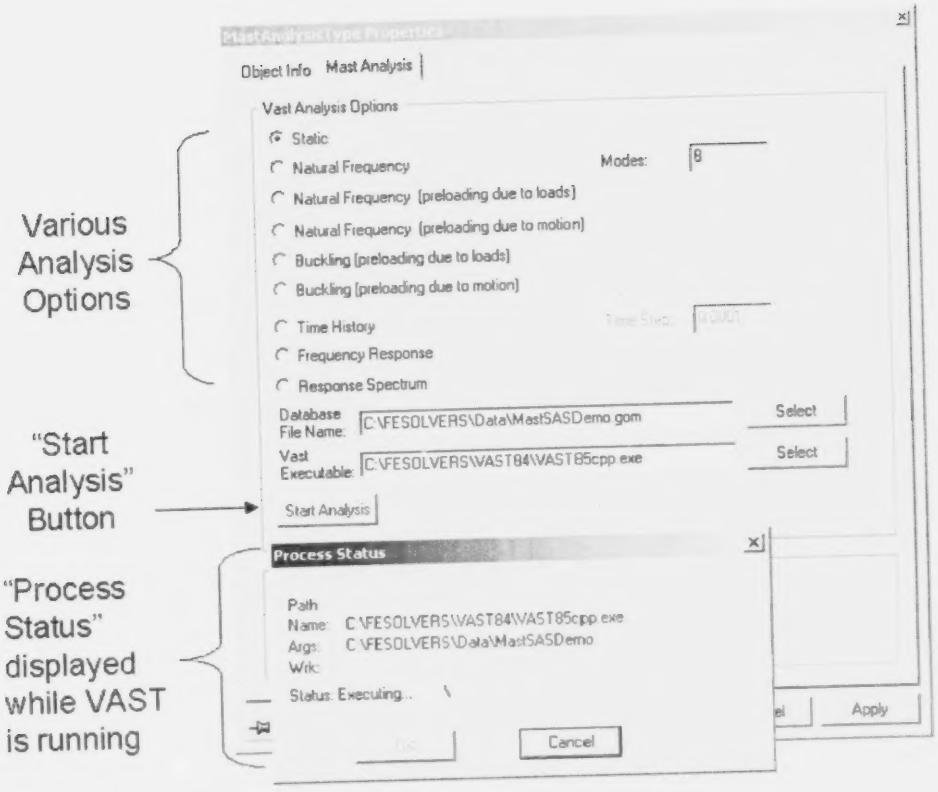
- **STEP 3**: Following the creation of the finite element mesh, users must export the model to the DSA database by selecting the "*Export DSA DB*" button. MASTSAS will then notify the user of a file identifying the VAST solver database files (for example, "c:\MastExample.vnc").



- **STEP 4**: Once the VAST Solver database files have been created, the user can then initiate an FE analysis by selecting the "*Analysis Setup*" option listed under the main menu's "*FE Model*" tab.



- **STEP 5**: At this stage, MASTSAS will provide the user with a series of analysis options to choose from. Once the user has selected the analysis type and has specified the location of the VAST solver, the analysis can be launched simply by clicking the "*Start Analysis*" button.


Various Analysis Options
"Start Analysis" Button
"Process Status" displayed while VAST is running
Object Info
Mast Analysis
Vast Analysis Options
Static
Natural Frequency
Modes:
8
Natural Frequency (preloading due to loads)
Natural Frequency (preloading due to motion)
Buckling (preloading due to loads)
Buckling (preloading due to motion)
Time History
Frequency Response
Response Spectrum
Database File Name:
C:\FESOLVERS\Data\MastSASDemo.gom
Select
Vast Executable:
C:\FESOLVERS\VAST84\VAST85cpp.exe
Select
Start Analysis
Process Status
Path
Name: C:\FESOLVERS\VAST84\VAST85cpp.exe
Args: C:\FESOLVERS\Data\MastSASDemo
Wrk:
Status: Executing...
Cancel
Apply

10. POST-PROCESSING WITHIN MASTSAS

The MASTSAS system is designed to provide post-processing capabilities that are specific to mast structural systems. General finite element post-processing capabilities, such as display of displacements, stresses, strains, mode shapes, etc., can be done within the supported finite element solver packages (i.e., DSA-VAST and ANSYS, respectively). With this premise, MASTSAS' post-processing capabilities have be developed for lattice type masts only, whose members require additional integrity checks. The MASTSAS system provides post-processing capabilities for evaluating the adequacy of:

(a) the strength of lattice mast members;
(b) the stability of lattice mast members; and
(c) the ability of lattice mast members to avoid vortex shedding.

The procedures for providing these adequacy checks are in accordance with the methodologies described by Crocker et al (1999). The steps involved in evaluating the strength and stability requirements of the mast members are summarized in the accompanying MASTSAS Reference Manual.

11. REFERENCES

[1] Lichodzijewski, M., MacAdam, T.,"HOOD User's Manual", Martec Technical Report TR-99-05, February, 1999

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MASTSAS – Mast Structural Analysis Software, User's Manual

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Brennan, D. P., Koko, T.S., and Rushton, P. A.

5. DATE OF PUBLICATION (month and year of publication of document)	6a. NO. OF PAGES (total containing information Include Annexes, Appendices, etc).	6b. NO. OF REFS (total cited in document)
April 2004	89 (approx.)	1

7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered).

CONTRACTOR REPORT

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include address).

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9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant).	9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written).
11gc26	W7707-008062/001/HAL

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MASTSAS (MAST Structural Analysis Software) is a special-purpose, PC based computer program for rapid finite element modeling of warship mast structures. The MASTSAS software was developed under contract to DRDC Atlantic, using its HOOD (Hierarchical Object Oriented Database) toolkit. This user's manual is one of a series of three manuals documenting the MASTSAS software. It provides detailed instructions on how to use this MASTSAS model generator to create input data, set up, and run the finite element based analysis programs, and display analysis results.

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Finite element modeling
Composite structure
HOOD
Object oriented programming